June, 1973
Price, $1.50

Can Science and Engineering Be Sexless?
Two papers on the present and future of women in science, to celebrate the centennial of M.I.T.'s first alumna

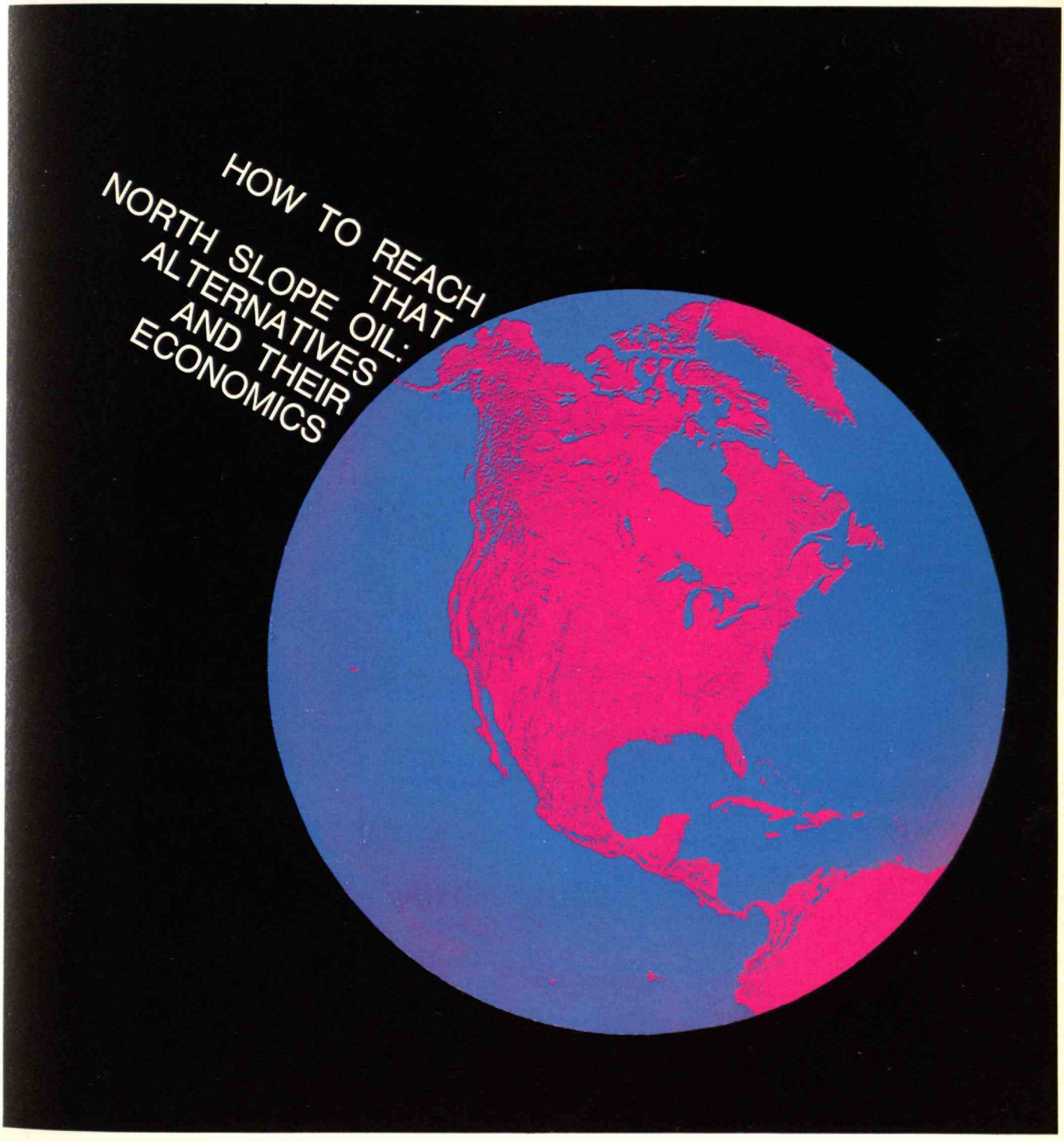
Edward E. David, Jr., on energy policy

Amar G. Bose on high-fidelity sound (first of two parts)

Daniel J. Fink on ERTS: new perspectives on Earth from space

Edited at the Massachusetts Institute of Technology

TechnologyReview



technology
review
Published by MIT

SPECIAL REDUCED ALUMNI RATES

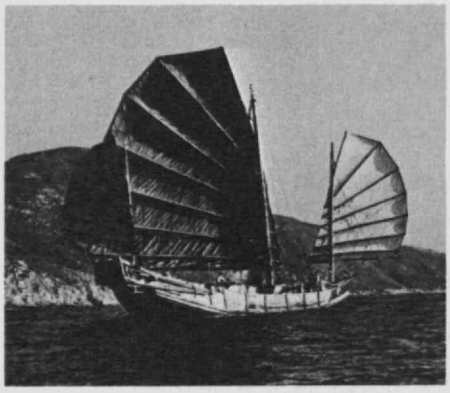
NINTH ANNUAL TOUR PROGRAM—1973

This unique program of tours is offered only to alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Univ. of Pennsylvania, Columbia, Dartmouth and certain other distinguished universities and to members of their families. The tours are designed to take advantage of special reduced air fares which offer savings of hundreds of dollars on air travel. These are not for mass "charter" trips but special fares which apply to regular jet flights of the major scheduled airlines and which are usually available only to groups or in conjunction with a qualified tour. The savings are as much as $500 over the normal air fare, and special rates have also been obtained from hotels and sightseeing companies.

The tour program is consciously designed for persons who normally prefer to travel independently and covers areas where such persons will find it advantageous to travel with a group. The itineraries have been carefully constructed to combine as much as possible the freedom of individual travel with the convenience and savings of group travel. There is an avoidance of regimentation and an emphasis on leisure time, while a comprehensive program of sightseeing ensures a visit to all major points of interest.

The unusual and limited nature of tour membership results in well-educated, intelligent and well-traveled participants. The size of each tour group is limited, with specifics being given in the tour materials.

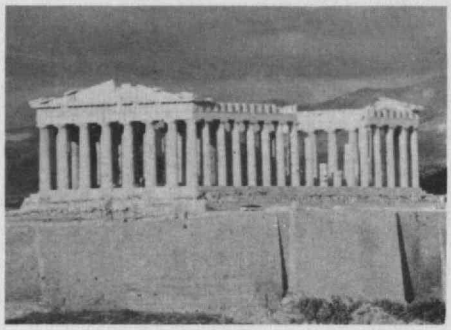
The tours use the best hotel available in every city, and hotel reservations are made as much as two years in advance in order to ensure the finest in accommodations. The names of the hotels are listed in each tour brochure, together with a detailed day-by-day description of the tour itinerary.



THE ORIENT

29 DAYS $1899

This outstanding tour, now in its ninth year of operation, offers the splendor and fascination of the Far East in comfort and at a realistic pace. The itinerary devotes eleven days to the beauty of JAPAN, visiting the modern capital of TOKYO, the lovely FUJI-HAKONE NATIONAL PARK, and places special emphasis on the great "classical" city of KYOTO, where the splendor of ancient Japan has been carefully preserved, together with excursions to NARA, the great medieval shrine at NIKKO, and the giant Daibutsu at KAMAKURA. Also included are BANGKOK, with its glittering temples and palaces; the cosmopolitan metropolis of SINGAPORE, known as the "cross-roads of the East"; the unforgettable beauty of HONG KONG, with its magnificent harbor and famous free-port shopping, and as a special highlight, the fabled island of BALI. Tour dates include outstanding seasonal attractions in Japan, such as the spring cherry blossoms, the beautiful autumn leaves, and some of the greatest annual festivals in the Far East. Total cost is $1899 from California, $2005 from Chicago, and $2172 from New York, with special rates from other cities. Departures in March, April, May, June, July, September, October and November 1973 ($27 additional for departures in July, September and October).



AEGEAN ADVENTURE

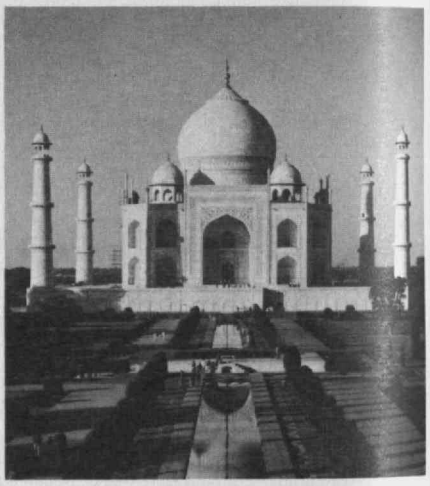
22 DAYS $1429

This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean, and Asia Minor—not only the major cities but also the less accessible sites of ancient cities which have figured so prominently in the history of western civilization, complemented by a cruise to the beautiful islands of the Aegean Sea. Rarely has such an exciting collection of names and places been assembled in a single itinerary—the classical city of ATHENS; the Byzantine and Ottoman splendor of ISTANBUL; the site of the oracle at DELPHI; the sanctuary and stadium at OLYMPIA, where the Olympic Games were first begun; the palace of Agamemnon at MYCENAE; the ruins of ancient TROY; the citadel of PERGAMUM; the marble city of EPHESUS; the ruins of SARDIS in Lydia, where the royal mint of the wealthy Croesus has recently been unearthed; as well as CORINTH, EPIDAUROS, IZMIR (Smyrna) the BOSPORUS and DARDANELLES. The cruise through the beautiful waters of the Aegean will visit such famous islands as CRETE with the Palace of Knossos; RHODES, noted for its great Crusader castles; the windmills of picturesque MYKONOS; the sacred island of DELOS; and the charming islands of PATMOS and SANTORINI. Total cost is $1429 from New York. Departures in April, May, July, August, September and October 1973.

SOUTH AMERICA

32 DAYS $1995

From the towering peaks of the Andes to the vast interior reaches of the Amazon jungle, this tour travels more than ten thousand miles to explore the immense and fascinating continent of South America: a brilliant collection of pre-Colombian gold and a vast underground cathedral carved out of a centuries-old salt mine in BOGOTA; magnificent 16th century churches and quaint Spanish colonial buildings in QUITO, with a drive past the snow-capped peaks of "Volcano Alley" to visit an Indian market; the great viceregal city of LIMA, founded by Pizarro, where one can still see Pizarro's mummy and visit the dread Court of the Inquisition; the ancient city of CUZCO, high in the Andes, with an excursion to the fabulous "lost city" of MACHU PICCHU; cosmopolitan BUENOS AIRES, with its wide streets and parks and its colorful waterfront district along the River Plate; the beautiful Argentine LAKE DISTRICT in the lower reaches of the Andes; the spectacular IGUASSU FALLS, on the mighty Parana River; the sun-drenched beaches, unforgettable mountains and magnificent harbor of RIO DE JANEIRO (considered by many the most beautiful city in the world); the ultra-modern new city of BRASILIA; and the fascination of the vast Amazon jungle, a thousand miles up river at MANAUS. Total cost is $1995 from Miami, $2080 from New York, with special rates from other cities. Optional pre and post tour visits to Panama and Venezuela are available at no additional air fare. Departures in January, February, April, May, July, September, October and November 1973.



MOGHUL ADVENTURE

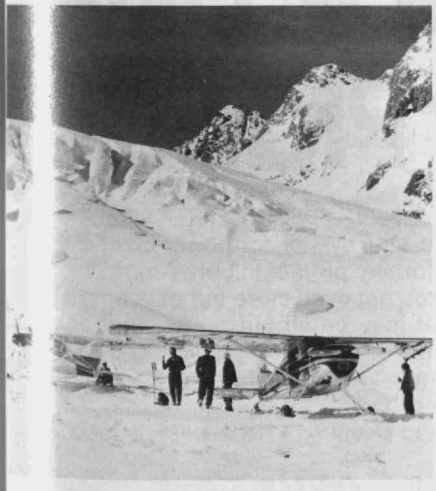
29 DAYS $1825

An unusual opportunity to view the outstanding attractions of India and the splendors of ancient Persia, together with the once-forbidden mountain kingdom of Nepal. Here is truly an exciting adventure: India's ancient monuments in DELHI; the fabled beauty of KASHMIR amid the snow-clad Himalayas; the holy city of BANARAS on the sacred River Ganges; the exotic temples of KHAJURAHO; renowned AGRA, with the Taj Mahal and other celebrated monuments of the Moghul period such as the Agra Fort and the fabulous deserted city of Fatehpur Sikri; the walled "pink city" of JAIPUR, with an elephant ride at the Amber Fort; the unique and beautiful "lake city" of UDAIPUR; and a thrilling flight into the Himalayas to KATHMANDU, capital of NEPAL, where ancient palaces and temples abound in a land still relatively untouched by modern civilization. In PERSIA (Iran), the visit will include the great 5th century B.C. capital of Darius and Xerxes at PERSEPOLIS; the fabled Persian Renaissance city of ISFAHAN, with its palaces, gardens, bazaar and famous tiled mosques; and the modern capital of TEHERAN. Outstanding accommodations include hotels that once were palaces of Maharajas. Total cost is $1825 from New York. Departures in January, February, August, September, October and November 1973.

THE SOUTH PACIFIC

29 DAYS $2100

exceptional and comprehensive tour of RALIA and NEW ZEALAND, with al post-tour visits to south seas islands s FIJI and TAHITI. Starting on the Island of New Zealand, you will visit untry's major city of AUCKLAND, the taking "Glowworm Grotto" at OMO, and the Maori villages, boiling and trout pools of ROTORUA, then New Zealand's South Island to explore tartling beauty of the snow-capped HERN ALPS, including a flight in a ly-equipped ski plane to land on the Glacier, followed by the mountains kes of QUEENSTOWN with a visit to a station and a thrilling jet-boat ride h the canyons of the Shotover River. the haunting beauty of the fiords at ORD SOUND and TE ANAU, followed English charm of CHRISTCHURCH, city of the southern hemisphere. Then to Australia, the exciting and vibrant nt where the spirit of the "old west" nes with skyscrapers of the 20th y. You'll see the lovely capital of ERRA, seek out the Victorian elegance ELBOURNE, then fly over the vast into the interior and the real OUT- country to ALICE SPRINGS, where nches are so widely separated that classes are conducted by radio, then the undersea wonders of the GREAT IER REEF at CAIRNS, followed by a SYDNEY, magnificently set on one of orld's most beautiful harbors, to feel the ic forces which are pushing Australia Limited visits to South Pacific islands s Fiji and Tahiti can also be included at ditional air fare. Total cost is $2100 California. Departures in January, Feb- April, June, July, September, October ovember 1973.



EAST AFRICA

22 DAYS $1739

A luxury "safari" to the great national parks and game reserves of East Africa, offering a breathtaking combination of wildlife and scenery: game viewing in the wilderness of Kenya's Northern Frontier district at SAMBURU RESERVE; a night at world-famous TREETOPS in the ABERDARE NATIONAL PARK; the spectacular masses of pink flamingos at LAKE NAKURU; multitudes of lion, zebra, wildebeest and other plains game in the MASAI-MARA RESERVE and the famed SERENGETI PLAINS; the great permanent concentrations of wildlife in the NGORONGORO CRATER; tree-climbing lions along the shores of LAKE MANYARA in the Rift Valley; photographing rhino and other big game against the majestic snow-covered background of Mt. Kilimanjaro in the AMBOSELI RESERVE; and the vast and fascinating wilderness of TSAVO NATIONAL PARK, renowned for its elephant and lion and for the unusual desert phenomenon of the Mzima Springs. There is also a stay in NAIROBI, the most fascinating city in East Africa, as well as features such as a visit to a MASAI MANYATTA to see tribal dancing and the tribal way of life. The altitude in East Africa provides an unusually stimulating climate, with bright days and crisp evenings (frequently around a log fire), and the tour follows a realistic pace which ensures a full appreciation of the attractions visited. Total cost is $1739 from New York. Optional extensions are available to the VICTORIA FALLS, on the mighty Zambezi River between Zambia and Rhodesia, to UGANDA, and to the historic attractions of ETHIOPIA. Departures in January, February, March, May, June, July, August, September, October, November and December 1973 ($26 additional for departures in June, July and August).

NORTH AFRICAN ADVENTURE

Preliminary Announcement

A new tour to North Africa and the regions which surround it, visiting GIBRALTAR, MOROCCO and the CANARY ISLANDS. GIBRALTAR, the gateway to North Africa, is the first stop, followed by a crossing of the narrow Strait of Gibraltar to TANGIER, on Morocco's northern coast. From Tangier, the tour proceeds by road to the imperial cities of MEKNES and FES, with an excursion to the Roman ruins of VOLUBILIS, then crosses the Atlas Mountains to the pre-Sahara and ERFOUD, on the edge of the desert. From here, the famed "casbah trail" leads through TINERHIR and OUARZAZATE to MARRAKECH, where an extended stay is provided before continuing to CASABLANCA. The visit to the CANARY ISLANDS, lying off the coast of Africa, will include stops in TENERIFE, the volcanic island of LANZEROTE, and LAS PALMAS. It is anticipated that the tour will be of three weeks' duration and that it will be inaugurated in the fall of 1973. Further details, including the tour cost, will be announced as soon as possible.

MEDITERRANEAN ODYSSEY

Preliminary Announcement

An unusual blend of countries in the Mediterranean area, visiting TUNISIA, the Dalmatian Coast of YUGOSLAVIA, and MALTA. Starting in TUNIS, the tour explores the coast and interior of Tunisia: the ruins of the famed ancient city of CARTHAGE as well as the ruins of extensive Roman cities such as DOUGGA, SBEITLA, THUBURBO MAJUS and the magnificent amphitheater of EL DJEM, historic Arab towns and cities such as NABEUL, HAMMAMET, SOUSSE and KAIROUAN, the caves of the troglodytes at MATMATA, beautiful beaches at ZARZIS and on the "Isle of the Lotus Eaters" at DJERBA, and desert oases at GABES, TOZEUR and NEFTA. The beautiful Dalmatian Coast of Yugoslavia is represented by SPLIT, with its famous Palace of Diocletian, and the medieval walled city of DUBROVNIK, followed by the island of MALTA, with its treasure house of 17th and 18th century churches and palaces, where the Knights of St. John, driven from the Holy Land and from Rhodes, withstood the epic seige of the Turks and helped to decide the fate of Europe. It is anticipated that the tour will be of three weeks' duration and that it will be inaugurated in the fall of 1973. Further details, including the tour cost, will be announced as soon as possible.

* * *

Rates include Jet Air, Deluxe Hotels, Most Meals, Sightseeing, Transfers, Tips and Taxes. Individual brochures on each tour are available, setting forth the detailed itinerary, hotels used, and other relevant information.

* * *

For Full Details Contact:

ALUMNI FLIGHTS ABROAD
White Plains Plaza
One North Broadway
White Plains, N.Y. 10601

Technology Review

Edited at the
Massachusetts Institute of Technology
Volume 75, Number 7
June 1973

Articles

Departments

Letters

Metrication, No; Standardization, Yes!

There are serious questions for those who, like Lewis Blodgett and Victor Cohn (*see "Letters," February, p. 4*), are impatient with slow U.S. action toward adopting the metric system. Far more important than agreement on units of measurement is agreement on international standards. A U.S. 110-v. 60-Hz. electric motor, dimensioned in millimeters, would still be a poor buy for the European with 240-v. 50-Hz. power. International standards can effect international product compatibility; internationalizing the units would provide only pseudo compatibility, a kind of Madison Avenue attention to appearance rather than substance.

Furthermore, I have nowhere seen any evidence that proponents of the metric system have recognized the pervasiveness of our measuring system throughout every smallest detail of our society. They seem oblivious to the fact that such a metric mandate would perforce obsolete every engineering handbook and specification in the country—and Mother's cookbook also becomes illegal. (Without criminal or civil penalties metrication fails.)

I am motivated to write in disappointment that the *Review* seems to be parroting all the others, dreaming of homogenizing the world, forgetting the incredibly vast, costly, wasteful, and disrupting boondoggle this inflation-ridden country would have to survive to achieve metrication. Indeed, to the extent that our metrication increases *our* exports, foreign countries now operating in metric would find our metrication an advantage to *them* inundating us with their goods at lower cost. Their productivity, currently higher than ours, would increase the margin as ours deteriorates during the lengthy changeover period (41 years for Japan).

Lewis B. Simon
Oxnard, Calif.

That "M" Is only 1,000

In "The Oil Railroad" *("Trend of Affairs" for March/April, p. 71),* Professor R. L. Whitelaw is quoted as proposing to ship liquified natural gas from Prudhoe Bay to Chicago for 25 cents/million ft.^{3}. But one million ft.^{3} of natural gas weighs about 20 tons, and 20 tons does not get hauled 3,200 miles for 25 cents! I suspect

the 25-cent figure is supposed to be per 1,000 ft.^{3}.
L. P. Elliott
Berkeley, Calif.

Reader Elliott is correct, the Editor having fallen victim to an "M" which means one thing in physics and quite a different thing in fuels.—J.M.

The Secret of Innovative Success

In spite of all the writings and probably many hours of discussion by thousands of people, to which Erik A. Haeffner makes reference in "The Innovation Process" (*March/April, pp. 18-25*), something substantial is lacking even yet: there are numerous small business enterprises that fail when inspired innovations cannot be brought to fruition and large enterprises whose researchers and inventors have been thwarted because their innovations never got to see the light of day or never really got off the ground.

Considering such examples, one issue cannot be stressed too much: the timely and accurate determination of actual and visualized needs and wants of users and prospects, and precise description of them so that all involved can readily understand and accept them.

History is replete with fortunate circumstances where the determinor of needs and wants and the innovator or inventor were one and the same—Thomas A. Edison and Alexander Graham Bell for examples. But in this era things are not so cozy, and many people are involved—innovators and inventors, research and development people, general managers, manufacturing people, and marketing and sales people.

To me the secret to success in getting more innovations, inventions, and results of research and development into successful use is an ever-increasing sophistication of those who determine and describe the needs and wants of users and prospects—the marketing people and those who are supposed to have marketing savvy (in the case of a small business, this may be the owner). Such people must be professionals in their own right. The work of determining needs and wants of users and prospects involves correlating many, many reports from customers and field representatives; it also requires visualizing future needs and wants which users and prospects do not even sense themselves. This is no small task, and no inferior person need apply for the job.
Richard Cutts, Jr.
Boca Raton, Fla.

Superports: Controversy Revisited

Professor Henry S. Marcus (*in "The U.S. Superport Controversy," March/April, pp. 49-57*) suggests that supertankers might be off-loaded at mooring buoys placed sufficiently far out to sea to allow spilled oil to lose most of its toxic properties in two or three days of evaporation and dissolution before reaching shore. This remoteness argument is obviated by present environmental expectations and federal pollution laws. Even if such toxic properties are dissipated, the environmentalists do not care to have several thousand barrels of oil sludge washed onto the beaches. The Federal Water Pollution Control Act of 1972 does not allow such spills threatening coastal areas to go without containment and clean-up efforts by either the vessel's owners or the Coast Guard. Present spill response techniques dictate immediate commencement of clean-up efforts. A three-day delay would not be tolerated. Nevertheless, the discussion of this remoteness argument served to further illustrate the conflicts inherent in building any kind of superport.
Daniel R. Cherry
Cleveland, Ohio

Professor Marcus responds:

This letter does indeed help to point out the complexities of oil spills and offshore terminals. At the present time, we cannot guarantee that an offshore terminal will never produce oil spills, and we cannot guarantee that all oil spills will be cleaned up in an ecologically safe manner before they reach shore. Consequently, the problem is to allocate research and planning efforts between such different factors as designing better oil spill prevention systems, creating better oil spill containment and clean-up systems, and locating offshore terminals far enough from shore to minimize the possible ecological effects of having an oil spill reach the shore line.

The environmental, economic, and social effects of having a three-day-old oil spill reach a beach are another set of complex issues entirely. The three-day-old oil spill without the toxic effects of fresh oil will cause some immediate ecological harm by smothering some living animals with its thick residue, but minimal long-term ecological damage will result. Far greater may be the short-term costs in terms of clean-up expenses, aesthetic loss of recreational areas, and commercial losses to adjacent resort interests. In France chemicals were used to sink an oil spill so that it would not reach a resort-area beach. The long-term ecological damage caused by this maneuver may actually have been greater than if the oil had been allowed to wash up on the shore and had been cleaned up there. Coastal regions around the world in danger of being affected by oil spills in their adjacent oceans must consider carefully their priorities of societal values.

Technology Review, Reg. U.S. Patent Office, is published eight times each year (in October/November, December, January, February, March/April, May, June, and July/August) at the Massachusetts Institute of Technology; two special editions are provided for graduate (pp. 1-80) and undergraduate (pp. 1-112) alumni of M.I.T. Entire contents copyright 1973 by the Alumni Association of the Massachusetts Institute of Technology. Technology Review is printed by the Lew A. Cummings Company, Manchester, New Hampshire. Second class postage paid at Boston, Mass., and at additional mailing offices.

Inquiries regarding editorial contents, subscriptions, and advertising should be addressed to: Technology Review, Room E19-430, Massachusetts Institute of Technology, Cambridge Mass., 02139. Telephone area code (617) 253-4872.

Price: $1.50 per copy, $9 per year in the United States, $10 in Canada and foreign countries. Please allow three weeks for changes of address, and give both old and new addresses in all requests.

Technology Review is represented for advertising by: Littell-Murray-Barnhill, Inc., 60 E. 42nd Street, New York, N.Y., 10017, telephone (212) 867-3660; Cole, Mason and Deming, 221 No. LaSalle Street, Chicago, Ill., 60601, telephone (312) 641-1254; Zander, Coughlin and Thompson, 5478 Wilshire Boulevard, Los Angeles, Calif., 90036, telephone (213) 938-0111 and 22 Battery Street, San Francisco, Calif., 94111, telephone (415) 398-4444.

Staff
Donald P. Severance, Publisher
John I. Mattill, Editor
Ralph Segman, Managing Editor
Richard F. Wright, Advertising Manager
Joseph J. Martori, Circulation Director
Ruth King, Associate Editor Emerita
Janet Kreiling, Associate Editor
Kathleen B. Sayre, Production Manager
Michael Feirtag, Assistant Editor
Margaret Kelly, Assistant Editor
Deborah A. Short, Advertising Assistant
Dorothy R. Finnerty, Circulation Assistant

Morality and Ethics of Fetal Research

Washington Report:
Victor Cohn

The subject of discussion was the human fetus, a briefly living creature suddenly exposed to possible access by scientists with scalpels and cannulas as the result of liberalized abortion policies in several nations.

In the words of a recent exchange in a bio-ethical newsletter, the subject was "The Human Fetus as Useful Research Material."

"The . . . issue," said Dr. Andre Hellegers of Georgetown University to his fellow members on an advisory council to the National Institutes of Health, "is that outside the uterus the fetus is either dead or alive . . . I would say there is no (ethical) problem if it is dead."

But Dr. Hellegers protested with deep moral conviction against an earlier recommendation by an N.I.H. study section for a set of guidelines condoning and governing research on living human fetuses. "It appears from this statement," he said, that we want to make the lack of any chance for survival of a still living fetus "the reason for the experiment."

"Isn't that the British approach?" asked Dr. Ben M. Peckham of the University of Wisconsin.

"It was the German approach," answered Dr. Hellegers. "'If it is going to die, you might as well use it.'"

This fascinating exchange was one of a number that saw first public light, followed by swift and negative official disapproval this spring as the result of an enterprising news report in *Ob. Gyn. News,* a doctors' newspaper. (I found page proofs of the report in my mail one Monday morning) and the editors of the *Washington Post* agreed that the subject should have a prompt and prominent airing.

There was nothing unusual, of course, about the last fact. Friends commonly ask a newspaper reporter, "Didn't you people print that story to make such and such happen?" or "Didn't you hesitate to

do it for fear it would have such and such effect?" Reporters at their best let no personal feelings interfere with their faith that news should be aired.

The news in this case combined science and sensation, with a touch of horror and, less obvious perhaps, the question of where lay compassion—with the already doomed fetus or with yet unconceived children who might benefit from fetal research?

Or was this question itself improper, given the humanity and helplessness of the voiceless fetus?

I don't know. I could only get on the telephone that Monday and begin checking with officials and professors and members of those newly-exposed advisory panels—to report in Tuesday morning's newspaper that:

"The possibility of using newly-delivered human fetuses—products of abortions—for medical research before they die is being strenuously debated by federal health officials.

"So is the question of whether or not federal funds ought to be used to support such research in a country where abortion itself is considered immoral by millions."

Fetal Research Dilemma

The details at this point were in general these: The types of abortions most commonly performed in the United States—suction or dilation and curettage early in pregnancy and saline injection ("salting out") later—produce only fragmented or dead fetuses. But in abortion by caesarean section performed to a small extent in the U.S. and to a large extent in some other countries where salting out is considered too risky to the mother—the product may be a partly formed human being.

"Partly formed" is a key fact. It means first of all that this being cannot be kept alive indefinitely by any means. Its lungs are still collapsed and solid. It will be born with its heart beating, but its brain will die within minutes. The heart can beat for some time longer, and, if an operating team provides the fetus with freshly oxygenated blood it may be kept alive, brain and all, for at least three or four hours.

For some minutes, then, or in some cases some hours, this "pre-viable" or partly formed fetus is certain to attract the developmental scientist who would learn more about all the ways children in the womb develop or mis-develop.

In September 1971 an N.I.H. Human Embryology and Development Study Section—academic advisers to N.I.H. officials—accordingly recommended that: "Planned scientific studies of the human fetus must be encouraged if the outlook for maternal and fetal patients is to be improved . . . Techniques used for temporary maintenance of functional integrity of isolated organs (should) be applicable . . . for terminal studies of the abortus . . . (But) under no circumstances (should) attempts be made to maintain indefinitely the functional integrity of a deliberately aborted fetus."

Also, said this group, a fetus used for study should be very surely non-viable: no older than 20 weeks, no more than 1.1 pounds in weight and no longer than 9.8 inches, or meet at least two of these rules.

By September 1971, some U.S. scientists were working on such fetuses during at least the first, fully alive moments. To some extent they were doing so in the U.S., to a much greater extent in Scandinavia, Britain, Japan and, increasingly, Finland, where doctors strongly prefer caesarean to salting out in mid-term.

By 1971, too, some British investigators were engaging in at least two reported practices that raised wide public concern: buying aborted fetuses from some unscrupulous doctors and keeping them alive by artifical means for, it was charged, 15 or more hours or even "days."

In May 1972, a British government-appointed commission called for stricter controls on such research, while agreeing that it was so important to the health of future generations that it should continue.

In March 1972, however, N.I.H.'s National Advisory Council on Child Health and Human Development was more cautious. It too agreed that "scientific studies of the human fetus are an integral and necessary part of research concerned with the health of men and women." But "acceptable" guidelines, it said, must still be developed.

Such guidelines, it was felt early this year, would probably be forthcoming, although some N.I.H. officials remained unsure. On that springtime Monday, for example, Dr. Charles U. Lowe—scientific director of N.I.H.'s National Institute for Child Health and Human Development and chairman of the group charged with considering such guidelines—told this reporter: "I haven't decided in my own mind yet whether we can go along with Great Britain, using federal dollars."

Continuing Dialogue

The reason was soon apparent. The *Post*'s Tuesday morning story triggered a barrage of protests from Roman Catholic spokesmen and groups, and on Thursday nearly 200 Catholic high school students and others met with N.I.H. officials in a protest organized by three students including the 17-year-old daughter of 1972 Democratic Vice Presidential Candidate R. Sargeant Shriver.

N.I.H. opened the meeting with a sweeping and speedily written policy statement. N.I.H. "does not now support" any research involving live fetuses," it was announced, and "we know of no circumstances at present or in the foreseeable future which would justify N.I.H. support."

Dr. Lowe, addressing the students, modified the disclaimer very slightly by adding: "You know we're dealing with 14,000 grants," and "we are not insofar as we know" financing any such work.

It took no more than a dozen phone calls for this reporter to find some scientists who had done such studies—mainly abroad—or were still doing, so, either with N.I.H. funds or with other funding, after which they returned to their own institutions where their work became a part of a whole that was supported at least in part by N.I.H. research, training or institutional grants.

It is hard in fact to separate Uncle Sam from any American medical research endeavour. N.I.H. today finances nearly half of all such research and the federal government as a whole finances nearly two-thirds of the $3.5 billion a year total.

And lest anyone doubt that he who pays the piper seeks to call the tune, Dr. Lowe told the students that "in practice what we have set" as policy "becomes common currency." Dr. John Sherman, N.I.H.'s Acting Director, told a reporter that any N.I.H.-supported scientist found to be doing studies on live abortuses would be asked to stop even if that research was otherwise funded. Dr. Lowe added that "I object strongly to professional scientists doing in other countries what ethics here will not permit."

But whose ethics? Even Dr. Hellegers—Director of Roman Catholic Georgetown University's Kennedy Institute for the Study of Human Reproduction and Bioethics, strong opponent of both abortion and research on live abortuses—had in an interview on that Monday urged "an N.I.H.-wide study" and "investigation" preceding any decision. Dr. Kurt Hirschhorn, Professor of Genetics at Mount Sinai Medical School, New York, and proponent of such research had urged a public-scientist dialogue.

Dr. Hellegers of course argued that "a fetus is a person at any stage of development, a member of the human race," while Dr. Hirschhorn said: "It is not possible to make this fetus into a child, therefore we can consider it as nothing more than a piece of tissue."

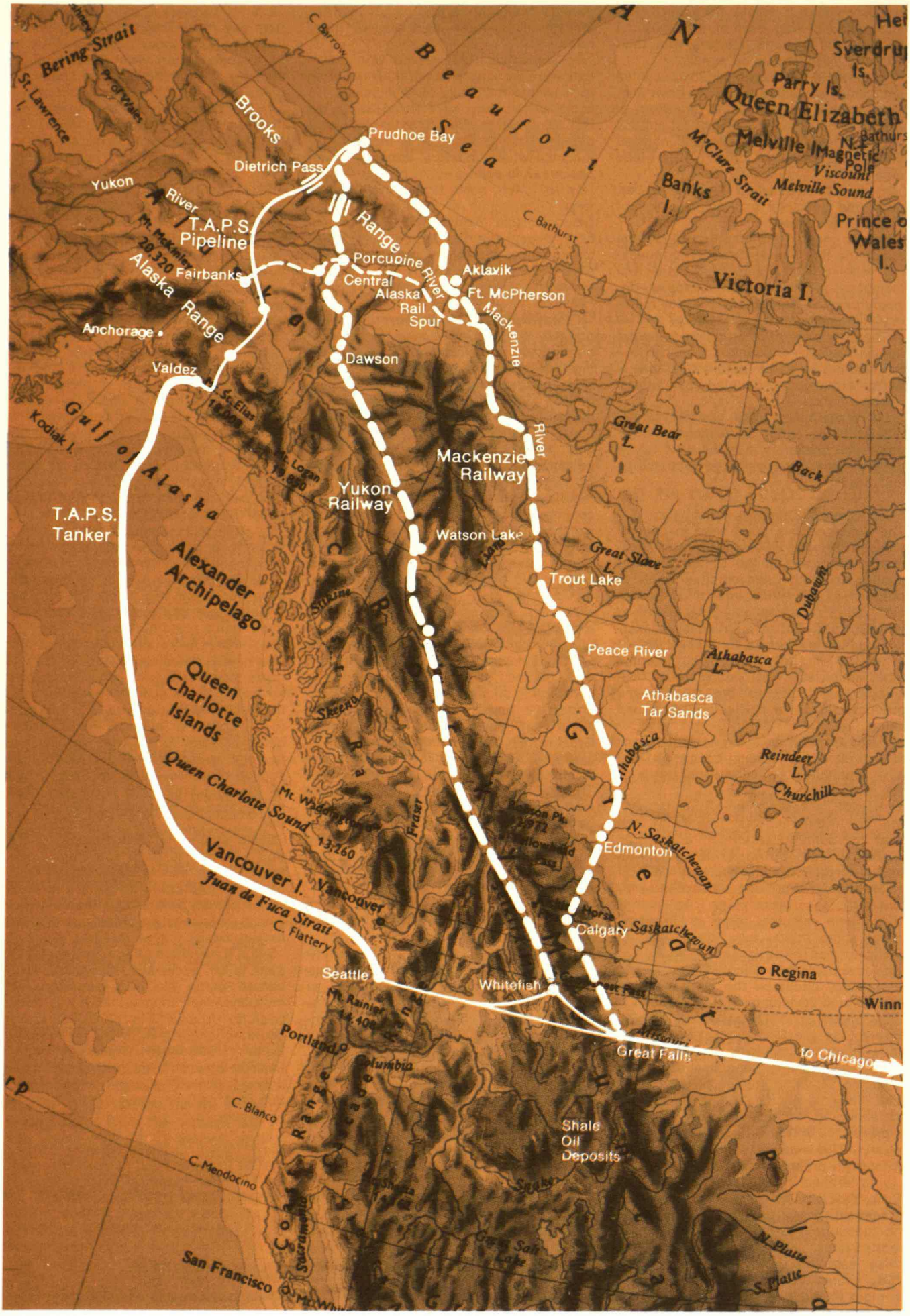
Few others were this blunt, but in other interviews scientists doing fetal work made statements like: "What needs to be said is that we need to get information that will help the unborn who are going to be born, not aborted. Rather than it being immoral to do what we are trying to do, it is immoral—it is a terrible perversion of ethics—to throw these fetuses in the incinerator as is usually done, rather than to get some useful information."

Some studies of living fetuses will no doubt be continued in some other countries, though almost surely fewer Americans will go there to do them. One would hope that any living thing, viable or nonviable, would always be treated with human dignity.

But is it any more ethical for the government to tell a scientist what he cannot do abroad or in his own laboratory with someone else's money than it would have been for Urban VIII to tell Galileo that he could no longer look at the sky? Perhaps we are not ready for a sane public-scientists dialogue on this subject so closely linked to the still uneasy subject of abortion, but are we ready for official proscription?

Victor Cohn, formerly Science Editor of the Washington Post, *is now concentrating on major science-oriented reporting assignments for that newspaper.*

(Columns continued on p. 72)


Bering Strait
St. Lawrence I.
C. Barrow
Beaufort Sea
Prudhoe Bay
Brooks Range
Dietrich Pass
Yukon River
T.A.P.S. Pipeline
Mt. McKinley 20,320
Fairbanks
Alaska Range
Anchorage
Valdez
Porcupine River
Central Alaska Rail Spur
Aklavik
Ft. McPherson
Mackenzie River
Dawson
Gulf of Alaska
Kodiak I.
St. Elias 18,008
Mt. Logan 19,850
T.A.P.S. Tanker
Yukon Railway
Mackenzie Railway
Watson Lake
Trout Lake
Great Bear L.
Great Slave L.
Alexander Archipelago
Queen Charlotte Islands
Queen Charlotte Sound
Vancouver I.
Juan de Fuca Strait
C. Flattery
Seattle
Mt. Rainier 14,408
Portland
Columbia
Mt. Waddington 13,260
Fraser
Vancouver
Peace River
Athabasca L.
Athabasca Tar Sands
Reindeer L.
Churchill
N. Saskatchewan
Edmonton
Calgary
S. Saskatchewan
Regina
Whitefish
Great Falls
to Chicago
Shale Oil Deposits
C. Blanco
C. Mendocino
San Francisco
Parry Is.
Queen Elizabeth Is.
Melville I.
Banks I.
Victoria I.
Prince of Wales I.
M'Clure Strait
Viscount Melville Sound
C. Bathurst
Back
Dubawnt
Great Slave L.
Missouri
N. Platte
S. Platte

Richard A. Rice
Professor of Transportation
Carnegie-Mellon University

How to Reach that North Slope Oil: Some Alternatives and their Economics

Early in 1968 exploratory drilling in the Prudhoe Bay region of the North Slope of Alaska confirmed the existence of about 10 billion barrels of recoverable oil, increasing United States oil reserves in North America by 35 per cent and prompting a series of engineering proposals for schemes to move the oil to market in the lower 48 United States.

The first proposal is for an 800-mile, 48-inch Trans-Alaska Pipeline System (T.A.P.S.), which would extend southward from Prudhoe Bay to the Port of Valdez, where it would be transferred to tankers for shipment to the West Coast of the U.S. Designed to deliver 600,000 barrels of oil per day initially, the system's capacity would be stepped up to an ultimate daily flow of 2 million barrels. The present estimated gross cost of facilities—including oil pipelines, transfer terminals, tankers, and a gas pipeline—from Prudhoe Bay to Chicago is more than $9 billion. A transport price of about 90 cents per barrel of crude on the West Coast is proposed, implying a price of $1.50 for oil moved to the Midwest and $1.70 to the East Coast.

Of the three Alaska-to-Chicago oil-and-gas transport routes roughly delineated on this map, the two crossing Canada are railways proposed by the author while the combined oil pipeline and ocean tanker system (T.A.P.S.) is favored by the oil companies and the U.S. Department of the Interior. Each railway would be accompanied by a gas pipeline, but in following the Mackenzie corridor, the T.A.P.S. gas pipeline would run an entirely different route than the oil. The T.A.P.S. oil route is 4200 miles long, and its oil-and-gas system would be hardest to build and least economical. The Yukon route covers 3600 miles, presents some severe construction problems, and would be more economical. The most economical and least difficult to build would be the Mackenzie route, although it is 3900 miles long. (Base map by permission of George Philip & Son Ltd., London, © 1971)

A second proposal is to carry the oil in ice-breaking tankers to the East Coast by way of the Northwest Passage. To test this idea, about $40 million was spent to re-equip the tanker "Manhattan" for a trial passage through the ice. The 4800-mile trip to New Jersey was found to cost $1.00 to $1.20 per barrel—20 to 50 per cent cheaper than T.A.P.S. delivery to the same port. Nevertheless, ice-breaking and environmental problems forced the Humble Oil and Refining Co., which converted and operated the "Manhattan," to shelve the plan indefinitely. We, therefore, will not consider the Northwest Passage scheme in this article.

A third plan for delivering North Slope oil to the lower 48 states is to construct a 3200-mile trans-Canada pipeline running north of the Brooks Range and east of the Rockies down the Mackenzie River Valley through Alberta to the Great Lakes area. The total capital—for delivery of 2 million barrels per day to Chicago and for an accompanying gas pipeline—is estimated at $5.6 billion. Because the Mackenzie oil pipeline was not investigated extensively in our study, it too will not be further discussed in this article.

The fourth and fifth proposals, based on technology that has received the least attention, are heavy-duty, two-track railways—both from Alaska to Montana, one of them through the Yukon River Valley and the other through the Mackenzie River Valley. The Yukon Valley system would cost about $7.45 billion and the Mackenzie Valley system $5.55 billion; they would deliver oil to Chicago for $1.40 and $1.30 per barrel, respectively.

The report of the U.S. Department of the Interior on the environmental aspects of the T.A.P.S. route positively assured its readers that full consideration had been given to the railway mode of oil transportation in the northern climate. But it is now evident that the thinking that went into the rail concept was not serious. Therefore, much of this article, which is derived from a 30-month study of long-range transport needs for North Slope oil, is devoted to a preliminary examination of the two railway alternatives.

On economic grounds—which is all that we will consider in this article—the Mackenzie Valley railroad is the superior system. The judgement is buttressed by additional economic arguments that predict what will happen once the Prudhoe Bay oil is depleted 20 years after extraction begins in earnest.

A Set of Assumptions

A number of general assumptions have been implicit throughout the study, and we will note them briefly here. The first has to do with the amount of North Slope oil. Geologists' and petroleum companies' inform us that there are about 10 billion barrels valued at about $20 billion at the wellhead. If the oil is to be extracted over 20 years, a daily

---

Richard A. Rice joined Carnegie-Mellon University about four years ago as Visiting Professor in the Transportation Research Institute after a 20-year career in the transportation industry. As Director of Research at the Greyhound Corporation and as an independent consultant, he contributed to such projects as the piggyback train, the unit train, the Scenicruiser, the auto train, and the containerized system. Now a transportation economist, he received a B.S. in geology at Princeton University and did graduate work in engineering at Harvard University.

The trans-Alaska pipeline-tanker system appears to be, by a significant margin, the least desirable of three alternatives for bringing North Slope oil to U.S. refineries and markets. The author opts for a high-capacity continental railroad.

volume of 2 million barrels is the desired capacity. Other possible deposits of oil may lie in nearby regions: to the west of Prudhoe Bay and south of Point Barrow is the Naval Petroleum Reserve No. 4, which, one must guess in the absence of published data, contains about 20 billion barrels. Another 10 billion barrels may lie to the east of the present fields toward the Mackenzie Delta. East of the delta in Canada there are probably larger reserves, recently estimated to be 30-40 billion barrels.

It is assumed that within a year after the transport of oil from the North Slope of Alaska begins, the movement of an estimated 20-30 trillion cu. ft. of natural gas must also begin. About one-third as much gas—in terms of b.t.u.—will have to be pumped, requiring a 48-inch, 4-billion-cu.-ft.-per-day gas pipeline.

A third assumption is that a multipurpose right-of-way would be preferable if it were found to be geographically and economically possible. That is, it would be best to try to combine the oil-transporting facility and the gas-transporting facility in one right-of-way.

Ordinarily, petroleum economics come first in the planning of oil transportation. A new set of priorities has been established in the movement of North Slope oil, however, and our final assumption is that they are in the following order: environmental protection; welfare of the state of Alaska from the social, resources, and conservation points of view; overall U.S. energy problems; and economics and the welfare of the oil companies.

Alaskan Geography

Almost all of the principal geographic features of Alaska are arranged in a basically east-west orientation. This includes the major coastlines, the principal mountain ranges and climatic belts, the main drainage patterns, the progression of vegetation belts, and the wildlife zones. All of these have played a key role in shaping the existing transportation network in the state, and all must also shape the mode and route that are finally chosen for the network that will move Alaska's oil and gas to consumers.

The northwestern portion of Alaska is a flat flood plain with the water table practically at the surface, marked by braided glacial streams carrying an excess of sediment. The plain is pitted by myraid small residual glacial ponds and meltwater lakes. Generally, the entire area is frozen solid from the two-ft. level down to possibly 200 or 300 ft. Basement rock may lie as deep as 300 to 1000 ft.

South of this Arctic slope are foothills and then the Brooks Range, which stretches roughly two-thirds of the way across Northern Alaska from east to west. The highest section lies to the east, where some of the peaks rise to 9000 ft.; farther west the peaks are 6000 to 7000 ft. high. Just to the east of the Brooks Range in Canada there is a low pass occupied by the Firth River at about 2000 ft. elevation. The only other crossing of such low altitude over the Brooks Range is at the head of the Anaktuvuk River Valley halfway across Alaska to the west.

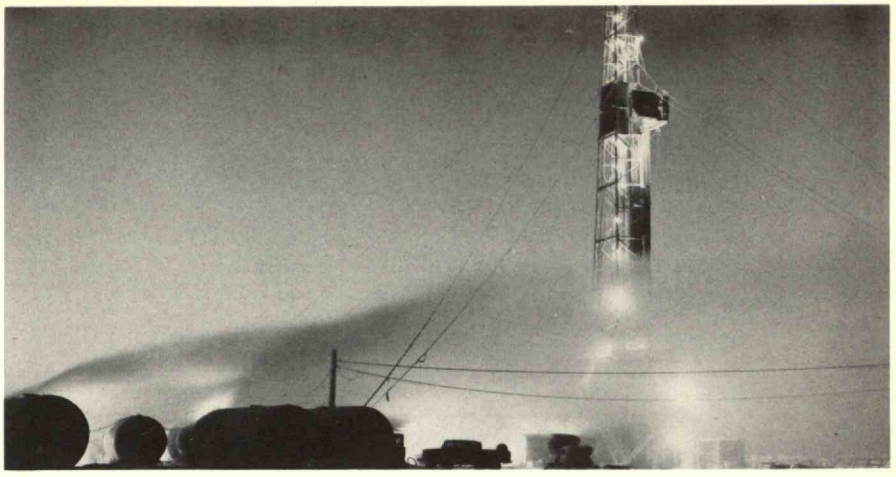
South of the Brooks Range is the Yukon Basin—in the west an area of dry plateau and low mountains containing Fairbanks, Alaska's third city, and in the east a vast area of semi-frozen peat bog and muskeg that is in some places hundreds of feet deep.

Travelling south from Fairbanks, before reaching the main mountains of the Alaskan Range, one crosses the Alaskan earthquake belt—a sweeping arc that is a continuation of the Aleutian Islands.

The twin mountain ranges of southern Alaska rise to 12,000 to 18,000 ft., many of the peaks being within a few score miles of the sea. Recent glaciation has gouged deep and treacherous U-shaped valleys throughout their extent; indeed, over 95 per cent of the glacial ice now in Alaska is in the mountain ranges between Fairbanks and Seward.

Only two passes suitable for surface transportation exist in these mountains from Fairbanks to the ports of Anchorage, Seward, or Valdez. One is now used by the single-track Alaskan Railroad and the new Fairbanks/Anchorage Highway; the other is the route of the Richardson Highway from Valdez to Fairbanks. Two facts suggest the difficulty of this terrain: (1) passenger trains on the Alaska Railroad average less than 30 miles an hour over the 356-mile trip from Anchorage to Fairbanks, and (2) leaving Valdez the Richardson Highway must rise 2800 ft. in about 20 miles. This contrasts sharply with the gentler terrain of the Alaska Highway from Fairbanks southeast along the Tanana River and into the Yukon Territory of Canada to White Horse. Following the trend of the main mountain chain, the Alaska Highway route traverses fare more conventional and favorable topographic and environmental conditions.

Three major route alternatives appear to exist for moving the North Slope oil out of Alaska.



This oil well was drilled in Canada's Northwest Territories at Atkinson Point, 50 miles northeast of Tuktoyaktuk. Steam blowing from heating boilers suggests the frigid conditions that Prudhoe Bay field crews will also face. (Photo: Imperial Oil Limited)

The Trans-Alaska Alternative

The trans-Alaskan corridor originally proposed by the T.A.P.S. group goes from Prudhoe Bay across the Brooks Range through the Anaktuvuk Pass or the Dietrich Pass, across the Yukon River, to Fairbanks, through the difficult terrain of the Alaska Range alongside the Richardson Highway, and into Valdez. From Valdez supertankers would carry the crude oil south to Seattle, where it would be transferred to a pipeline and started eastward to the markets.

The initial survey favored the Anaktuvuk Pass, which is broad with a level floor carved by the glaciers that receded some 12,000 years ago. Because of the objections to this route by environmentalists, who worried about the annual caribou migrations there, the Dietrich Valley corridor was surveyed across the Brooks Range at 4500 ft. altitude and down to Prudhoe Bay along the Atigun and Sagavanirktok River Valleys. This higher route would be more expensive to build and much more difficult to operate and maintain. But it is not as heavily traversed by caribou and apparently is not considered by environmentalists to be a crucial wildlife area.

Along either route the oil pipeline would be accompanied by a gravel haul-road, since pipelines should be about $500,000 less expensive per mile if they are constructed alongside an existing road and less still if near a single track access railway. The combined cost of a single-track railway and a hot-oil pipeline on one right-of-way from Fairbanks to the North Slope should be about the same as that of building the pipeline alone and without the convenience of the parallel railway to move heavy materials and equipment. Thus, in choosing between the two all-Alaska routes one is led to a preference for the one over the Anaktuvuk Pass, since the high-altitude Dietrich crossing of the Brooks Range presents serious construction problems. And the most economical T.A.P.S. combination seems to be a joint single track railway and oil pipeline through the Anaktuvuk corridor.

Another difficulty with the T.A.P.S. route is that the existing railway south from Fairbanks does not continue on to Valdez but instead veers west toward Anchorage. Construction of a pipeline beside the Fairbanks-Anchorage leg of the railway considered was by the T.A.P.S. group, but the route was deemed less desirable than the route to Valdez because harbor conditions at Anchorage were felt to be not as amenable to the handling of large tankers. The T.A.P.S. planners also had to take into account mountainous terrain and permafrost in the north, severe weather and operating conditions that require proper heat for oil to pass through pipe line and pumping facilities most of the year, the very great cost of moving equipment and materials to the areas north of Fairbanks, and the possibility of a major earthquake. Even more of a hazard to a pipeline than earthquakes is the occasional damage resulting from landslides and snow slides. Crammed harbor conditions in the Valdez Arm of Prince William Sound and the task of coordinating frequent tanker movements through the 50 miles of straits and islands to the south make this alternative problematical, notwithstanding the favor it has among the T.A.P.S. planners. Other complications that contribute to the high costs of the system include the necessity of the additional sea movement, a fleet of supertankers, new superport facilities, and a second tank farm in Seattle.

An essential part of either trans-Alaska oil pipeline system is a gas pipeline taking an entirely different route—eastward from Prudhoe Bay down the Mackenzie Valley to the U.S. Aside from the economic disadvantages of two separate systems moving oil and gas out of the Prudhoe Bay fields, it is possible that the gas pipeline might be ruled environmentally infeasible; then the whole question of transporting North Slope gas would have to be restudied.

The Yukon Railway Alternative

The proposal for a high-capacity, two track railway that would connect Alaska and Montana through the Yukon Territory and British Columbia was evolved because it avoids the caribou migration route through the Anaktuvuk Valley, bypasses the present boundaries of wildlife refuges in northeastern Alaska, and keeps clear of the very difficult terrain in the earthquake and glacier belt of the Alaska Range south of the Yukon River. This 3600-mile route seems to involve fewer environmental problems.

However, because the railway would have to climb to an altitude of about 3000 ft. and tunnel seven miles through the Brooks Range above the Sagavanirktok River, it would cost more to construct and operate than the Mackenzie railway.

Location of the gas pipeline with the oil delivery system along the Yukon corridor has the advantage that its construction would cost about $0.5-to-$1 million per mile, half the cost of a separate route east from Prudhoe Bay. However, it would appear difficult, if not impossible, to locate both the railway and the gas pipeline in the same Brooks

Range tunnel. The problem of a rail accident in the tunnel and subsequent rupture of the pipeline appears almost insurmountable. For this reason, we recommend that a separate alignment for the gas pipeline be sought at the crossing of the Brooks Range. (Possibly this would involve nothing more than the pipeline climbing to a higher altitude and taking a shorter tunnel route.)

The Yukon corridor would be the shortest and most convenient route for an access and resource railway from the 48 states to Alaska—an important factor in the moving of oil field equipment from the petroleum-producing areas in the United States to the North Slope.

If the total cost and time considerations were not critical, the Yukon route would provide the best all-round solution from the United States point of view for the development of its 49th state and for the two-way movement of resources and materials.

The Mackenzie Railway Alternative

The third route configuration runs east from Prudhoe Bay along the Arctic shore, southeast through the Mackenzie Valley in the Northwest Territories to Alberta, and then to the U.S. The attractions of this route are many from a purely economic and geographic point of view. It is the only one that does not cross the continental divide or any mountain range. If a gas pipeline is to be built along this alignment in any case, then it seems wise to consider at least part of the same route for the oil-moving system. The Mackenzie Valley route has the shortest mileage from the North Slope oil fields to the most-likely marketing areas in Canada and the U.S.—3300 miles between Prudhoe Bay and Chicago, while the Yukon corridor spans 3600 miles and the T.A.P.S. pipeline-tanker-pipeline system 4200 miles. It would probably be the lowest priced combined route system, notwithstanding the fact that the oil railway would drop off the Chicago-bound gas pipeline and detour 600 miles to a Montana terminal.

If Canada and the U.S. were part of the same nation, and if the weather problems on the north end of the Mackenzie route were not so extreme, it would be almost axiomatic that little consideration would be given to either of the other alternatives. The geography of this system suggests that it should be the most economical to construct and the least difficult to operate.

To provide the requisite 2 million barrels of oil per day the system would consist of a heavy-duty resource railway with two widely spaced tracks on a 40-ft.-wide graded way using heavy welded rail and whatever construction turns out to be best suited to low Arctic temperatures. On this route, grades could be limited to 1 per cent (50 ft. to the mile) and curves to a 2500-ft. radius. Tank-car unit-trains could be operated at speeds of 40 to 50 m.p.h.

One serious drawback is that the route must cross the recently established Alaskan Wildlife Reserve, although much of the problem could be avoided if the railway were located close to the Arctic Ocean, where it would interfere little if at all with the migration of caribou of the nearby plains. A raised roadway would have to be built so that it would not interfere with the permafrost or drainage of the many small streams that flow from the Brooks Range into the Arctic Ocean.

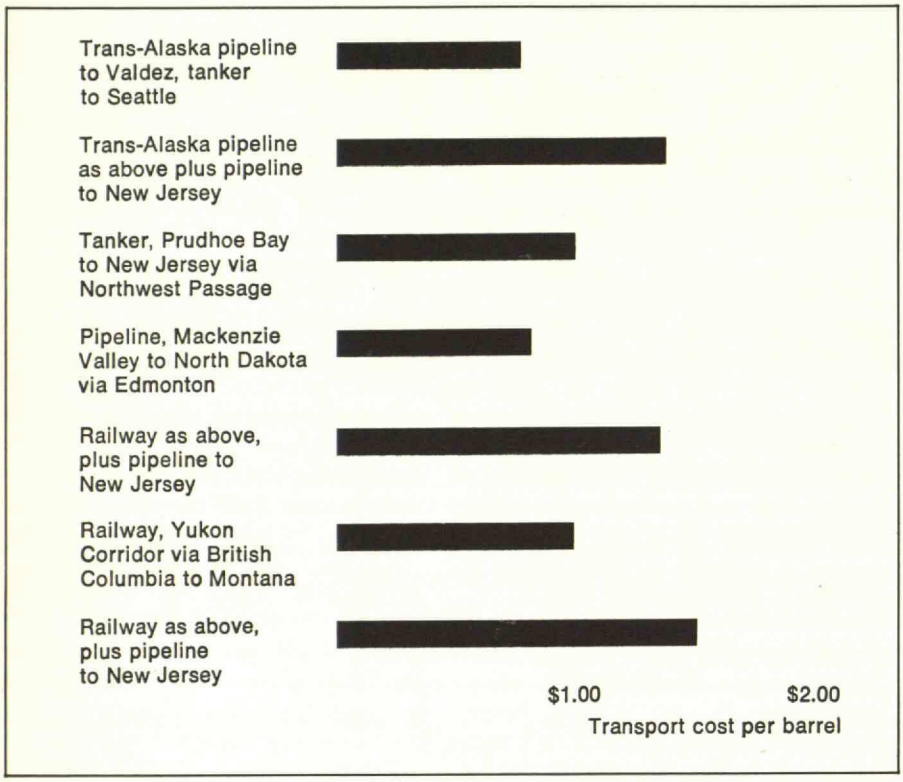
The Mackenzie corridor is a less convenient access route from the United States to the section of Alaska south of the Brooks Range that contain other potential mineral and forest resources. A single-track extension from the Mackenzie line through the upper Porcupine Valley into central Alaska might provide an access to the center of Alaska almost as good as the Yukon corridor. The single-track extension could also be used to help solve the dilemma of the 800 miles of 48-in. pipe that has already been purchased from Japan for $100 million and stored in various locations in Alaska. Should the Mackenzie Valley railroad be selected, the pipe could be adapted for natural gas transmission. The sections stored at Valdez and Fairbanks could be moved east from Fairbanks and then southeast to a connection with the Mackenzie railway. This could be done by first building a single track access railway running east from Fairbanks and south of the Yukon River to a connection with the Mackenzie route. After the Mackenzie railway is completed, the pipe stored at Prudhoe Bay could be laid out to connect with the pipe coming from the opposite direction.

It should be mentioned here that Arctic railways and unit trains have been in successful operation in various locations. Oil and gas are transported in north-central Europe, as are mineral ores by unit-train, under geographical and traffic conditions comparable to those contemplated for Alaska and Canada. A unit-oil-train system of the type under study delivers crude oil from Montreal to the Port Huron generating station. Likewise, hundreds of miles of railroad are used above the permafrost line, some of it north of the Arctic Circle, under dense traffic and heavy snow-fall conditions, and

	T.A.P.S. pipeline/tanker/pipeline route: Prudhoe Bay—Valdez—Seattle—Chicago	*Yukon Corridor high-capacity rail/pipeline route: Prudhoe Bay—Montana—Chicago*	*Mackenzie Valley high-capacity rail/pipeline route: Prudhoe Bay—Montana—Chicago*
	Millions of dollars		
Crude oil pipeline cost, Arctic sections	$3000	—	—
Pipeline cost, U.S. proper	900	$ 800	$ 700
Railway cost, Arctic sections	—	1500	1200
Railway cost, Canada midsections		2000	1500
Tanker fleet cost	900	—	—
Tanker port facilities	150	—	—
First transfer, pipeline to tanker	100		
First transfer, rail to pipeline	—	150	150
Second transfer, tanker to pipeline	100	—	—
Natural gas pipeline cost	4000	3000	2000
Total gross facilities cost	**$9150**	**$7450**	**$5550**
Less savings to producers by use of railway for northbound equipment (15 years: 10 billion barrels @ 25¢)	—	2500	2500
Less residual value of the system after depletion of Prudhoe Bay oil	950*	1475†	1175†
Adjusted 20-year commitment	**$8200**	**$3475**	**$1925**

**The residual value represents the tankers, port facilities, and pipelines built in the continental U.S.*
†*The residual value represents a portion of the Alaska-Canada Canadian rail line and pipelines built in the continental U.S.*

This chart (based on 1973 estimates) summarizes the author's economic arguments for construction of a high-capacity railroad to bring oil from the North Slope of Alaska to the U.S. midwest by way of Canada. The initial cost of the railroad system is substantially less than that now estimated for the trans-Alaska pipeline-tanker system which would transship North Slope oil through Valdez, Alaska. The rail link offers two additional advantages: its availability for bringing supplies and machinery to the North Slope fields, and its residual value for transporting oil which may be discovered elsewhere in the western Arctic, and which is known to be in the Athabasca tar sands of Canada and the shales of some of the U.S. Rocky Mountain states. Economic development of Alaska, which the author believes would be stimulated by the two-way rail lines, is not evaluated in the chart.



If the market for North Slope crude oil were on the U.S. West Coast, the plan for a trans-Alaska pipeline transshipping to tankers at Valdez, Alaska, would have substantial economic advantage. But the author's analysis suggests that by far the least expensive way to bring Alaskan oil into the U.S. Midwest and East, where it is most needed, is by an overland high-capacity railroad along the Rocky Mountain Trench or the Mackenzie River in Western Canada.

over more difficult terrain than that proposed for the Yukon and Mackenzie lines.

Construction Costs . . .

Normally, a double-track resource railway costs $800,000 to $1,000,000 per mile in temperate climates. It appears that routeway costs north of 55° latitude—which includes much of the construction discussed here—would be as high as $2 million per mile. Rolling stock and repair shops would cost about $500 million per 1000 miles, not appreciably more than in benign regions.

☐ The present estimate for the 2200-mile Yukon rail line to Whitefish, Montana, is about $3.55 billion—$2.4 billion for the finished routeway, $1 billion for rolling stock and equipment, and $150 million for a rail-to-pipeline transfer terminal. A 1500-mile crude-oil pipeline to complete the delivery to the Midwest would cost about $800 million and a gas pipeline $3 billion (see table on page 16). The total estimated cost of the Yukon system then is about $7.45 billion.

☐ A double-track railway on the Mackenzie Valley route of about 2500 miles to Great Falls, Montana, would cost about $2.1 billion. Grading and earthwork should be somewhat simpler here. Rolling stock and repair facilities would add about $600 million. The 3300-mile Prudhoe-to-Chicago gas pipeline would contribute $2 billion to the cost of the Mackenzie system—if it is built on the existing rail routeway. Adding a $700 million oil pipeline from Montana to Chicago and $150 million for a transfer facility brings the total to about $5.55 billion.

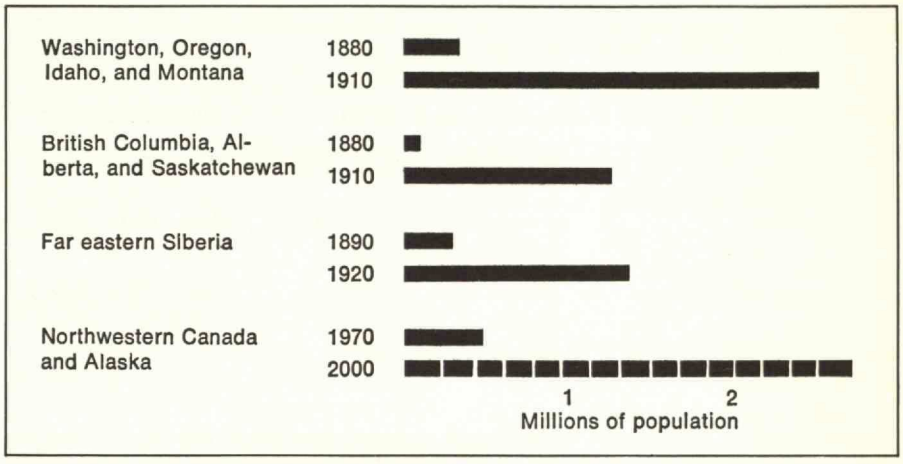
☐ The current estimated cost of the T.A.P.S. oil pipeline, crossing 800 miles over two mountain ranges and three ridges between Prudhoe Bay and Valdez, is about $3 billion. This is by far the most expensive per-mile pipeline ever proposed. (One reason for the concern that stimulated the present study was the rapid rise of this estimate—from $1 billion when the T.A.P.S. plan was first announced in 1969). Standard supertankers of 100,000 tons for the fleet to operate the Seattle-Valdez route are now estimated at about $30 million each. By the time the trans-Alaska pipeline would be delivering 2 million barrels of oil (300,000 tons) daily, a fleet of 30 such vessels would be required for the 1600-mile ocean leg of the T.A.P.S. route. The separate Mackenzie corridor gas pipeline called for in the T.A.P.S. plan would cost about $4 billion—twice the cost of the same route built along an existing railway. All these figures conspire to put the T.A.P.S. route total expense at about $9.15 billion, including $900 billion for a 2000-mile Chicago-Seattle pipeline, $150 million for port facilities

in Valdez, and $100 million each for Valdez and Seattle oil transfer terminals.

Thus the total initial facility investment for the main alternate routes from the North Slope to the U.S. Midwest varies from a low of about $5.55 billion for a railway system through the Mackenzie Valley to a high of $9.15 billion for the T.A.P.S. plan.

But upon depletion of the North Slope oil resources, the railway systems will have residual transportation value for the developing State of Alaska. This is hard to estimate, and a good many assumptions about economic development and future technology are involved; but, as shown in the table on page 13, our research suggests that, with an allowance for residual values, the lowest net outlay is then $4.375 billion for a Mackenzie Valley system. The highest is $8.2 billion for the T.A.P.S. system.

The commitment can be further adjusted to reflect the production savings in the North Slope oil fields from access for supplies and equipment that would be provided by the railway mode. This has the effect of lowering the field price of petroleum by about 25 cents a barrel. The readjusted lowest net commitment then is the Mackenzie rail line with $1.925 billion versus the T.A.P.S. route at $8.2 billion and the Yukon route at $3.475 billion.



Large increases in population have without exception followed within 30 years the arrival of transcontinental railroads. This was true in the American and Canadian West—and in Russia following completion of the Trans-Siberian Railroad in 1900. The author believes it will happen, too, in the northwestern areas of Canada and in Alaska if the Prudhoe Bay oil resources are exploited by rail.

. . . and Transportation Costs

Research by the Canadian Institute of Guided Ground Transport, (C.I.G.G.T.) Queens University, with support of the Canadian government and cooperation of the Canadian National Railroad, on the construction and operating details of a Mackenzie Railroad system (with an Alberta terminal) has shown that it could deliver 2,000,000 barrels of oil per day with 15 to 20 trains. If necessary, by using 30 to 40 longer trains, the railway could deliver double the estimated capacity of the T.A.P.S. pipeline or the Yukon railway. (Because the Yukon route is hillier, trains would be shorter and more frequent—perhaps 36 daily.) The additional Mackenzie capacity implies that both the existing Prudhoe reserves and new Canadian reserves could be brought out at the same time.

Oil transportation costs for the three different routes can be estimated on the basis of recent operating experience in bulk-freight unit-train movement and in large-diameter pipelines. Alaskan oil is presumed in these estimates to move first to a U.S. port-of-entry, and then to the U.S. Midwest. The projections are relatively simple to make. Since the base cost of transporting petroleum by 48 in. pipeline is already well known (25 cents per barrel per 1000 miles), only the increased pipeline construction cost factor need be applied to the delivery price. This generally amounts to about 10 cents per barrel more per 1000 miles for each increment of $600,000 per mile that a pipeline costs over a base cost of $600,000 per mile.

The transport rates tabulated on page 14 are for oil delivered from Prudhoe Bay to New Jersey. From the North Slope to Chicago, the T.A.P.S. rate would be $1.47 per barrel, the Yukon rate $1.42, and the Mackenzie rate $1.32 If the producing field is serviced by a railroad the cost of oil per barrel extracted would be $1.75. The absence of rail access would bring the field cost up to $2 per barrel. Thus, the total delivery price at Chicago would be: T.A.P.S., $3.47; Yukon, $3.17; and Mackenzie, $3.07.

In the most recent—more advanced—phases of the C.I.G.G.T. studies consideration is being given

Presumed General Per-mile Pipeline Costs
$1000s per mile, including pumps, storage, etc.

	Gas Pipelines			*Oil Pipelines*		
	36"	*42"*	*48"*	*36"*	*42"*	*48"*
Economical southern U.S. alignment	$250	$325	$400	$300	$400	$500
Typical alignment in northern and central U.S.	300	375	450	350	450	550
Southern Canada and Rocky Mountains	400	500	600	500	600	700
British Columbia, North Alberta, central Canada	600	700	800	700	850	1000
Remote Middle East Turkey, Iran, Egypt	650	750	900	750	900	1100
Central Russia and Siberia, good access	800	950	1100	900	1100	1300
North-central Siberia and northern Canada	1150	1300	1500	1500	1700	2000
Arctic Alaska and Canadian Far North	2000	2200	2500	2700	3100	3500

Data: current prices from petroleum industry journals

The author points out that the recently completed 40-in. Trans-Alpine pipeline from Trieste to Bavaria through the eastern Alps cost $645,000 per mile. Good access to the route kept the construction cost down. The pipeline passes through three 4.5-mile tunnels, while the T.A.P.S. pipeline would climb over the high, treacherous Dietrich Pass instead of tunneling.

to such cost-related details as the effects of the delay in delivering Alaskan oil (a rail system would take about a year longer than the T.A.P.S. pipeline to construct); a carousel system (illustrated on page 18) for fast multiple-car loading and unloading of unit oil trains; and the possibility of cutting the gas-delivery cost to the Great Lakes area from $0.90 down to $0.65 per 1000 cu. ft. by using cryogenic tankcars and powering the trains with "boil-off" gas from the tankcars, as is done on liquefied-gas ships.

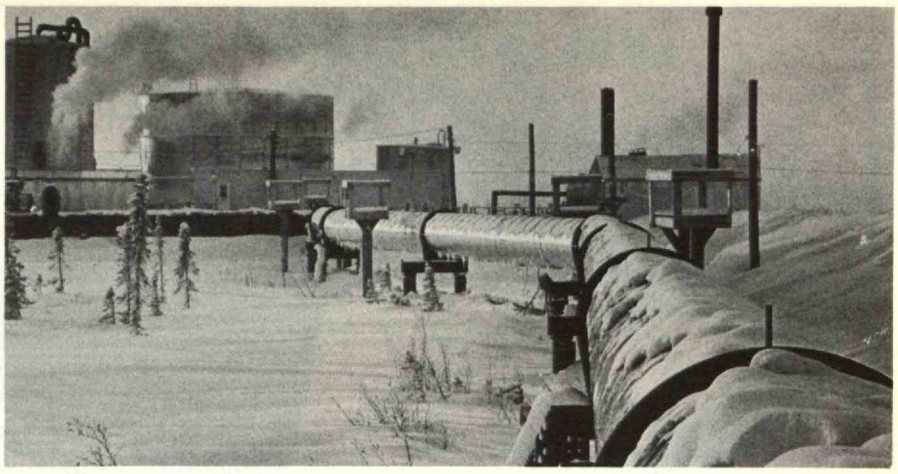
Impact on Alaska's Economy

Development of North Slope oil fields will accelerate the movement of the Alaskan economy (the Canadian Northwest is not included in this analysis) away from its virtual dependence on federal spending, and will eventually lead it to a more balanced growth. The flow of oil, together with the greater efforts in resource exploration and development that will follow a long-awaited native claim settlement, will boost the economy and more than compensate for the decreases in military spending in Alaska that must be projected for the next decade. At the projected influx of 15 families a day into Alaska, the present population of 305,000 could double in ten years, although a rise to 425,000 by 1980 is more likely.

In the coming 10 years, the commodity-producing industries of Alaska should take a larger share of state activity. At present, 18.7 per cent of civilian employment is in this sector compared to the 40 per cent national average. Oil production will assist future resource development by providing the construction, transportation, and communication facilities in the remote areas. These distributive industries will then grow along with the industries and population they support. Since the North Slope discoveries, 1,400 companies have registered to meet the requirements for doing business in Alaska.

Could a railroad built to carry oil from Prudhoe Bay to the Midwest handle a broad range of commerce more cheaply than the existing Alaskan Railroad and water transport to the West Coast? This would depend on the location of the demand for Alaskan resources in the contiguous 48 states and on Alaska's willingness to reconsider its policy that requires primary processing in the state.

Alaska has resources out of which rail traffic could be generated. Estimates of the maximum annual allowable yield of Alaska's interior forests have ranged from 660 million to 2.3 billion board feet. Logging in the Yukon Valley between the Canadian border and Fairbanks—with estimated annual yield of some 160



Study of pipeline operations under permafrost and Arctic meteorological conditions was conducted by Mackenzie Valley Pipe Line Research Limited near Inuvik, Northwest Territories, in cooperation with several oil companies. One major problem is that hot-oil pipelines can melt permafrost enough to eliminate support, thus leading to rupture of the heavy lines. (Photo: Imperial Oil Limited)

million board feet valued at $25 million—has been severely limited by its inaccessibility and its distance and isolation from potential markets. These problems would be mitigated by a railroad which would be both a customer for local timber products and a means of transport to major markets. Over 650 new jobs could be created, and employment could be highest in the winter, when logging operations are facilitated by the frozen ground.

A comparison to developed areas in Canada and in the 11 western states suggests a 10-fold potential increase of non-oil-and-gas mineral production in Alaska to $300 million annually by 1990. This could be achieved if some of the present constraints on development are eased—among them lack of access to potential sites, inadequate knowledge of resource potential, and outdated and inhibiting laws and policies governing mining and other development in Alaska.

The proposed rail lines would boost surveying activity in the Brooks Range and in the Yukon Valley. Substantial quantities of iron ore, coal, and other minerals, estimated to be widely distributed throughout the state, probably exist in these areas. A conservative estimate for the annual production in the Brooks-Yukon region by 1990, given a rail line, is two million tons of iron ore, one million tons of coal, and one-half million tons of other minerals—with a gross value of about $30 million.

In terms of accelerating regional development, the establishment of a direct-express rail system to central Alaska 2000 to 2500 miles from the border of the U.S. proper could be compared to the building of U.S., Canadian, and Russian rail systems of similar mileage and geographic spread in the late 19th century—as shown in the table on page 15. One may observe that northerliness apparently has not been a governing factor in the growth rates of the westerly regions in Canada and the United States after rail-access was completed.

The Tourist Dollar

Alaska's unique scenic, recreational, and wildlife attractions have produced an average 15 per cent annual increase in tourism from 1964- to 1970. The 107,000 visitors to Alaska in 1969 spent a total of $36 million, making tourism the state's fourth largest industry. At a projected average growth of 10 per cent per year, the number of tourists could reach 325,000 by 1980 and 500,000 by 1985, and expenditures $168 million (in 1969 dollars) by 1985.

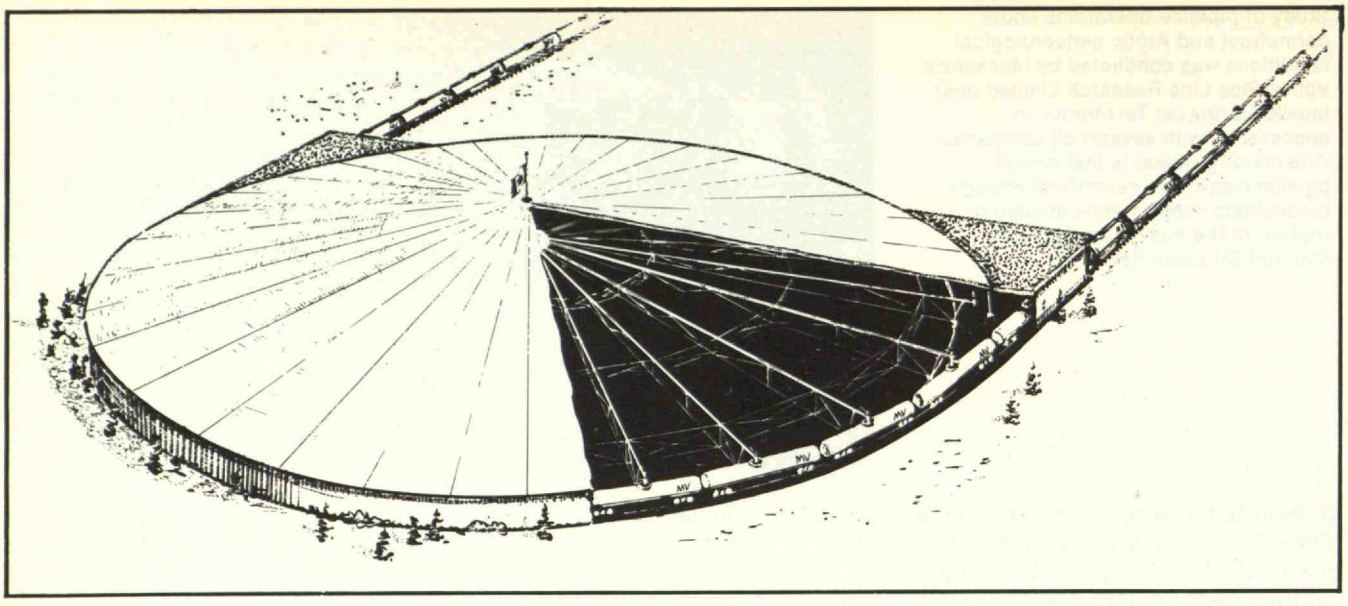
These estimates seem unduly optimistic in the face of the present restraints on tourist growth—lack of appropriate facilities for housing visitors, the great distance from the lower states, and the seasonality of tourist travel to Alaska. A high-speed rail link to Fairbanks from the Midwest would eliminate some of these constraints, and it is estimated that 200,000 of the 500,000 tourists who would travel to Alaska in 1985 would utilize such a rail service for at least part of their trip. Thus $50 million in tourist expenditures and the employment of 2000 to 2500 additional Alaskans could be among the economic spinoffs from an oil railroad 12 years from now.

The railroad would benefit, too, from the tourist revenues. Pullman passengers, traveling an average 3500-mile round trip at the rate of 3¢ per mile, would contribute $5.3 million to annual revenues. There is also a large potential in transported vehicles. If 40,000 of the transported vehicles pay 7¢ per mile, 8000 pay 10¢ per mile, and 2000 pay a mobile home rate of 15¢ per mile, they will generate $9.8 million in revenues. In addition, if each of these vehicles comes with an average of three travelers, and if the average distance traveled on a round trip in 2500 miles (accounting for many one-way trips), another $5.6 million in passenger revenues would be collected. Thus total revenues to a railroad from tourist traffic might reach $20.7 million by 1985.

Considering the long-range economic welfare of Alaska, and especially the development of tourism, the scales would be tipped somewhat more toward the Yukon corridor with a railway spur to the central region of the state. This more southerly route could be operated for the tourist trade over a considerably longer season—April to October—than the Mackenzie system. It also would have considerably shorter running time, lower cost for movement of goods, and slightly better access to all of the United States.

A Longer-Term View

Since a very substantial investment of effort, resources, and capital is about to be made to bring crude oil from the North Slope to the continental U.S., the size and worth of the Prudhoe Bay deposit needs to be put into better focus. The present estimate of these reserves represents a 35 per cent addition to the known petroleum reserves of the U.S. But the truth is that by 1985, when the U.S. may be consuming oil at the rate of 5 to 7 billion barrels a year, the Prudhoe oil will in fact amount to only a two-year supply for the



Fifteen tankcars at a time would be unloaded in this carousel terminal, conceived by the Canadian Institute of Guided Ground Transport. During the unloading, the cars would be inspected for defects and, if necessary, replaced.

nation. However, the combined, roughly estimated total reserves of the U.S. and Canadian Arctic—including the Prudhoe Bay oil—are 70-80 billion barrels. Most of it is not accessible to the T.A.P.S. oil pipeline. The Mackenzie route could conveniently serve in all of the potential North Slope oil regions.

A long-range consideration that generally is overlooked is that two of the three largest known oil deposits in the world lie near the regions traversed by the Yukon and, especially, the Mackenzie corridors. Recoverable reserves from the Athabasca tar sands of Alberta are estimated at 370 billion barrels—about the same size as the entire known Persian Gulf reserves. The shales of Colorado Utah, and Wyoming are thought to contain about 600 billion barrels of economically recoverable oil.

The Sun Oil Company has invested $300 million in a plant to develop oil extraction from the tar sands, and according to the *New York Times* the company feels that its operation could be in the black by the time of the next round of price increases in the crude oil market. The Shale Oil Corporation, recently joined by the Standard Oil Company of Ohio and the Atlantic-Richfield Company, and aided by more than 30 years of U.S. Bureau of Mines research, has been conducting extensive experiments and pilot operations for about a decade. S.O.C. believes its descending scale of costs is now at the same level as the ascending scale for developing conventional petroleum fields.

It would seem mandatory that any new refineries and petroleum-processing facilities built to handle the flow of Arctic oil in the central and western parts of the U.S. or Canada should be closely linked with the tar sand and oil shale formations. Montana would be a good compromise location, handy to both deposits. It would also make a convenient transfer point for the further distribution of crude oil and petroleum products to the Midwest, Rocky Mountain region, and Northwest, as well as to the East Coast. Looking beyond 1980, trans-Canadian rail routes look even more attractive.

It is therefore recommended that serious consideration be given to the alternate routes of the Yukon corridor through British Columbia and the Mackenzie corridor through Alberta. It now appears almost certain that high-capacity rail systems would be more economical to construct and operate and would yield greater residual value or follow-on utility after Prudhoe petroleum is exhausted.

Our study concludes that any decision to proceed now with construction of the trans-Alaska system from Prudhoe Bay to Valdez and thence to Seattle would be premature. Additional studies and any change in strategy for transporting the North Slope oil resources would of course further delay their utilization. But the size of the investment, the long-range planning needed to move the tremendous deposits of oil yet to be tapped in the U.S. and Canadian Arctic and tar sand and shale regions, and the issues of regional development and conservation fully justify that delay.

Amar G. Bose
Professor of Electrical Engineering
M.I.T.

Sound Recording and Reproduction

Part One: Devices, Measurements, and Perception

If the field of sound recording and reproduction didn't have so many experts—many of them not in the discipline of acoustics—I could confine myself to a straight-forward technical presentation of our research. But this field is one in which everybody knows something and almost everybody has some interest and some preconceived ideas. If I just made a technical presentation, some of the results would be so controversial that unless one also knew how they were developed, the mismatch between the preconceptions and the results would be severe. So I'll try to go through the years from '56 to the present. In this manner, I think I can present the developments in the way they occurred to us. The sequence will be evident; and when I arrive at some results that are quite controversial, at least you will see how they came about.

In 1956, I decided to purchase a HiFi. Like many engineers, I purchased it on strictly technical grounds. There was something called "flat frequency response."

Amar G. Bose received his S.B. and M.S. (1952) and his Ph.D. (1956) from M.I.T.; his doctoral thesis was on the characterization of non-linear systems, a matter under investigation by Professor Norbert Wiener. Professor Bose is co-author of *Introductory Network Theory*. He taught an undergraduate course on that subject for seven years, receiving M.I.T's Baker Award (Outstanding Teacher of 1963-64). In 1964, he founded the Bose Corporation, which conducts research and development in electronics and acoustics, and manufactures high fidelity components. This article is adapted from a presentation given by Professor Bose at a joint meeting of the Acoustical Society of America, the Institute of Electrical and Electronics Engineers (student chapter), and the Audio Engineering Society at M.I.T. last December. The second part of this two-part article will appear in *Technology Review* for July/August.

"Flat frequency response" was by definition a good thing, and one looked for it. "Uniform phase" was also supposed to be good; to an electrical engineer, flat frequency response and uniform phase are, in fact, the criteria for exact reproduction of a signal. "Polar response" was supposed to be round, as I remember, and "distortion" was supposed to be low.

In those days, these data were often printed on a piece of paper on the back of a loudspeaker. Like a good engineer, I normalized them all and picked the optimum speaker. I never consulted a salesman for fear that he had incentives to sell me different things than what the technical world might say were best. I was very confident; as a matter of fact, I didn't listen to the loudspeaker before I bought it, brought it home, and set it up. I even invited some people to hear the debut, for which I had bought some violin recordings.

It was a real shock when the violin started playing, and it was even worse for an ensemble of violins. When they got anywhere up on the E string the sound became sandy, shrill, and screechy. Real instruments never sound that way.

Of course the answer was that I must have bought a defective unit. So I marched back with my speaker, and this time I listened to other ones, more expensive ones. It seemed that the more money you spent, the more screech you purchased. When the salesmen were questioned about this, they would say, "Oh well, people who perform music never like HiFi, you know; they're biased. They don't listen to music in the audience, and this is the sound that HiFi reproduces. . ."

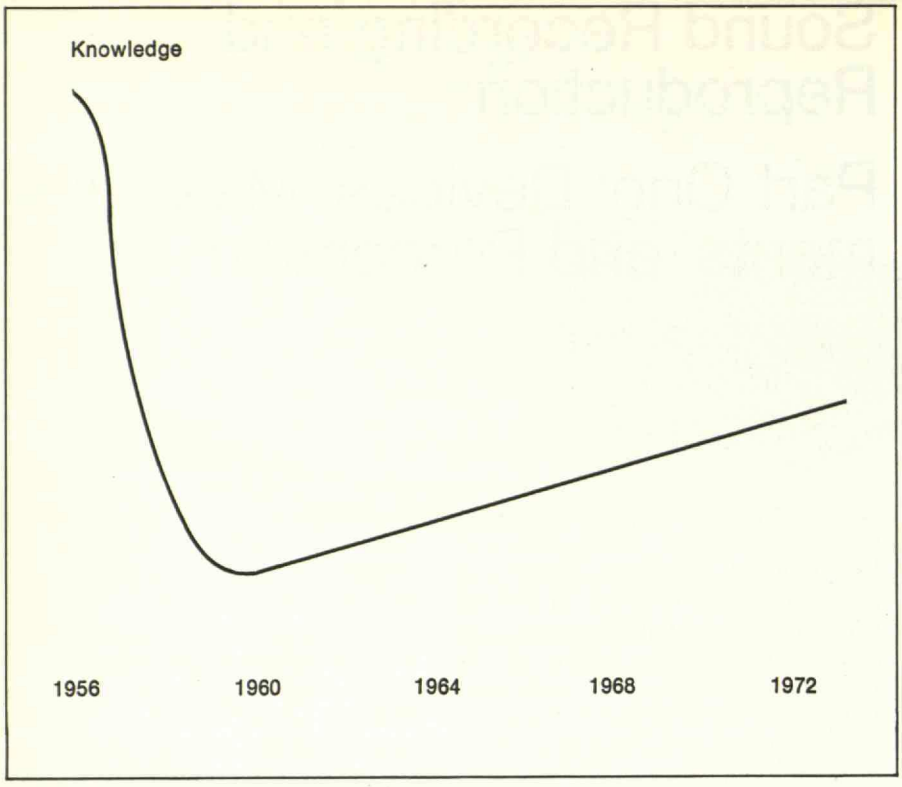
Something had to give. Either the specifications to which speakers were designed were wrong, or speakers weren't designed to those specifications correctly.

Into the Anechoic Chamber

Our curiosity led to many night-time projects. At that time, I was teaching in the field of communication theory and I had to do research in the field of acoustics at night. We had good facilities, though: an anechoic chamber—a room with totally sound-absorbent walls—and very good equipment. So we began making measurements on loudspeakers.

One way of depicting what happened thereafter is shown in the form of the curve on the next page, which I think will remain meaningful throughout this presentation. The horizontal axis is time in years; and vertically, we plot knowledge. Our knowledge started off very high in 1956 but by '59 our fund of knowledge was way down; it began turning around in '59; and it's come up a little bit since then. So if at the end of this presentation you know less than you do presently, this is exactly the story of my research from 1956 till now.

Let's start on our way down the curve of knowledge. Let's go into the anechoic chamber and measure a loudspeaker. By the measurement standards in all textbooks and by whatever international standards exist, one goes into an anechoic chamber and places a microphone in front of a loudspeaker, on axis, puts an electrical signal across the speaker's terminals, sweeps that signal across the audio frequency band and plots the amplitude of the microphone signal versus frequency. Supposedly, for a good loudspeaker, the result should be a frequency response that is flat.



Knowledge about loudspeaker design: By 1959, it had reached a minimum. "We recognized many fundamental problems, and we understood what was wrong with existing methods . . ."

When we measured loudspeakers, this never happened. The errors weren't two or three dB (factors of about 1.5)—they were twenty or twenty-five dB (factors of ten and more). We contacted one manufacturer to tell him that we could not measure the same curve that was printed on the back of his speakers. Without explanation, we were told that we were measuring frequency response incorrectly. After two or three more attempts at communication, with no further responses, we began thinking that perhaps that was the state of industry—they printed one curve but realized another. The thing to do, we decided, was to design a speaker whose frequency response really was flat. We never questioned the ingrained assumption that flat frequency response is the right thing to have. We wondered how to achieve it rather than if it should be achieved.

We were trying to get it when we began to realize that there was a problem.

What might be wrong with flat frequency response if we did manage to attain it? The obvious fact is that the environment in which frequency response is measured—the anechoic chamber, in which there are no echoes—is nothing like the environment in which loudspeakers are supposed to perform.

Let's see what happens when a loudspeaker that has flat frequency response in an anechoic chamber is placed in a living room. The best way to see what happens is to build one wall behind the speaker in the anechoic chamber as a first step toward converting the chamber into a living room.

Before we put in the wall, let's examine the loudspeaker's radiation pattern. (The illustration at the right). The radius from the origin to a point on the pattern is a measure of the sound pressure at that angle of radiation. It turns out that at low frequencies, where the wavelength of the sound radiated is large (50 Hz has a 23-foot wavelength) compared to a loudspeaker's dimensions, the radiation pattern of any speaker is spherical. It doesn't matter which way the speaker is pointing or what its shape is. The pattern is a circle in a plane; the pressure is equal all around. At high frequencies, where the wavelength is small compared to the speaker dimensions, things don't work this way. In this frequency range, the sound is radiated directionally, a shown by the 15 kHz polar pattern in the illustration.

Flat frequency response in a particular direction requires that at each frequency the speaker must deliver the same sound pressure in that direction for equal-amplitude voltage signals at the speaker terminals. Thus in the illustration the flat frequency response criterion requires that both radiation patterns must have equal radii along the forward axis.

Now we put a wall behind the speaker in the anechoic chamber. The 15 kHz radiation pattern doesn't change because, as the 15 kHz polar pattern indicated, high frequencies do not radiate behind the speaker. Sound is nothing more than a motion of molecules; if molecules are not moving in any area, an object can be placed there without affecting anything. But low frequencies do go back there. The 50 Hz signal in the illustration reflects from the wall and comes back out again. And at low enough frequencies the reflection is virtually in phase with the original radiation. The wall has therefore doubled the low frequency response as measured in front of the speaker. With just one wall, we have increased the frequency response by 6 dB at the low frequencies. The sound radiated in front no longer meets the criterion of flat frequency response. When we put a floor underneath the speaker, the same effect occurs again. If we build a corner wall next to the speaker, the low frequency sound pressure doubles yet again. This is, of course, what you have experienced if you have positioned a loudspeaker first in the middle of a room, then against the middle of a wall, then against the wall at the floor, and finally in a corner. Each of those steps will increase the intensity of the bass response of the speaker.

The point of all this is that the textbook criterion toward which we thought we should design—flat frequency response in the anechoic chamber—is incorrect. Even if we or anyone else had succeeded, our wonder speaker would have sounded like a jukebox when brought into a living room. At this point in time (1958) our knowledge was on its way down the curve shown above.

Our first thought was that since a speaker plays in a living room, we'll measure its frequency response there.

However, every room has reso-

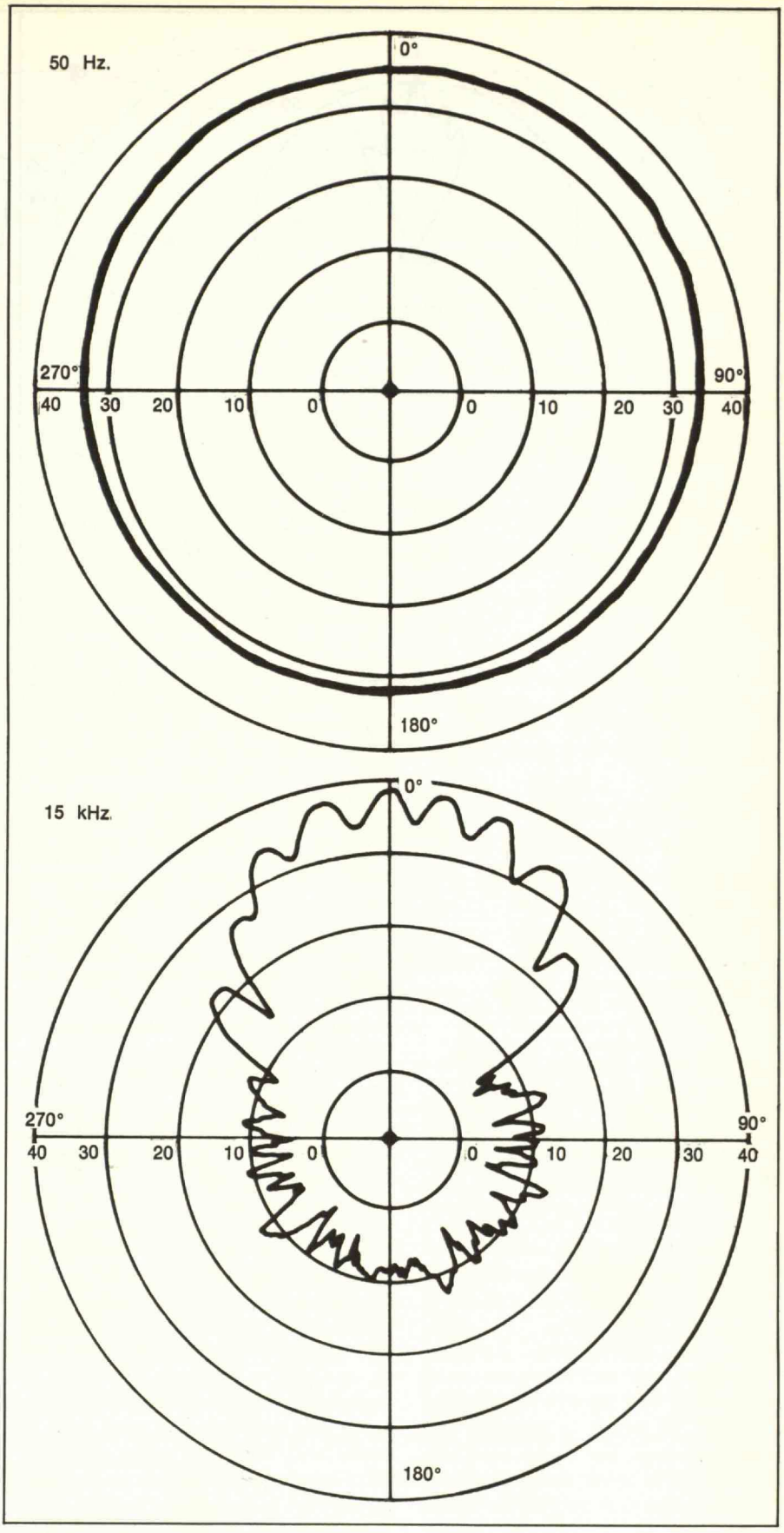
nances, caused by sound reinforcing itself through reflections from the walls, floor, and ceiling. The total number of such resonances or "normal modes" in a rectangular room 15 by 20 by 9 feet high is enormous—greater than fifty million over the entire audio band. These normal modes show up as peaks and dips in the frequency response between different points in the room. Each normal mode is like a narrow band filter that either boosts or attenuates the frequency to which it is tuned. Some of the normal modes alter the frequency response by as much as 20 or 30 dB.

We can now see the fundamental problem associated with measuring a loudspeaker in a room. If the frequency response between two points in a room contains a multitude of irregularities, how will we know which irregularities are peculiar to that room and which are inherent in the loudspeaker?

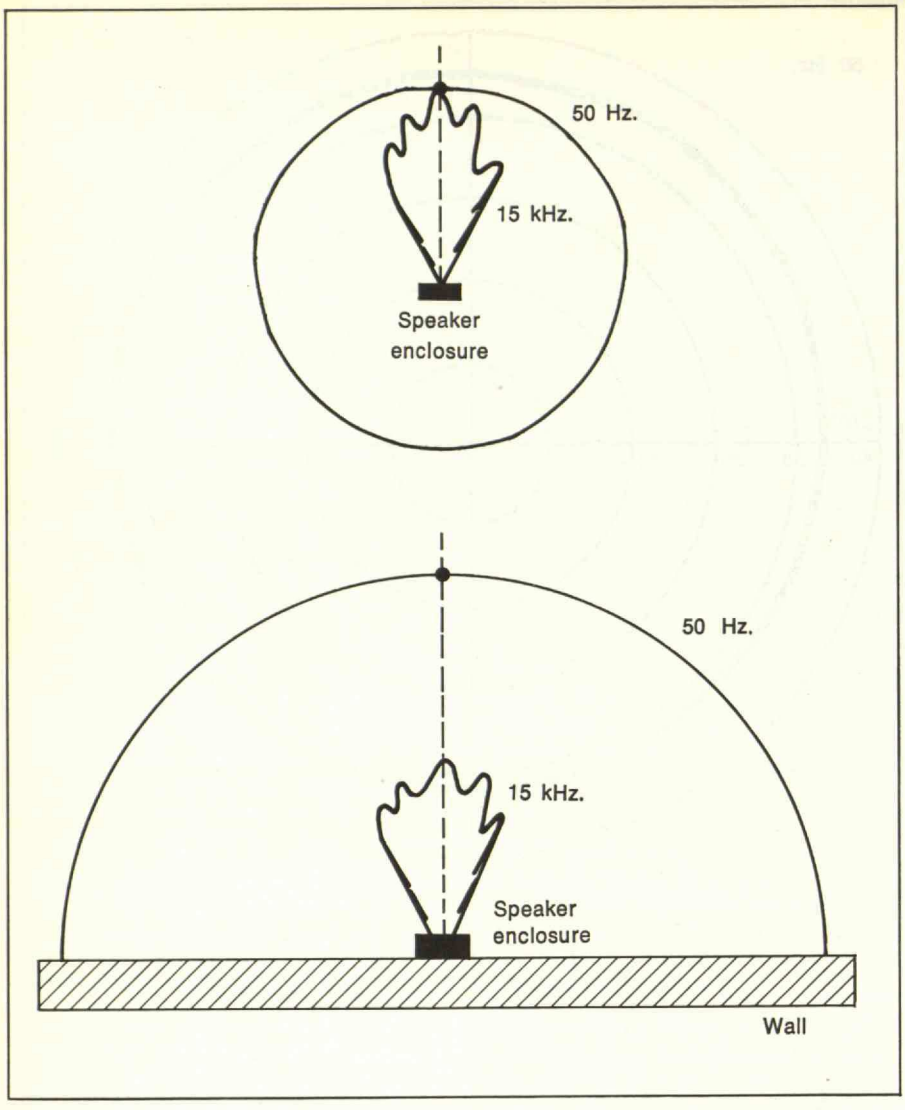
The Space of Sounds

Up to this point we have been identifying problems, as we were doing in '58 and '59. Let's now try to gain some perspective by examining the fundamental nature of problems that involve physical devices, physical measurements, and perception. Consider three abstract spaces (the illustration on page 23.). The first space is a space of devices. By this we mean that each point in the space represents a specific device. For example, point 1 might represent a particular speaker, point 2 a different speaker, point 3 a turntable, and so on. The second space is a space of measurements. That is, each point in this space represents a specific physical measurement that can be made on a device of space 1. The third space is that of perception. Different points in this space represent perceptibly different performances based upon the same music or speech signals passed through different devices.

Now consider a device such as a loudspeaker. We can make many measurements on it. Frequency response, polar response and distortion are examples of such measurements. In the illustration, we can represent a particular measurement made on a particular device by a line drawn from a point in the first space to a point in the second. Historically, designers have been preoccupied with creating devices in which certain



The radiation patterns, at a low frequency (top graph) and a high frequency (bottom graph), of a loudspeaker in an anechoic chamber. Six dB difference between two measurements corresponds to a doubling of sound pressure. At 15 kHz, the pressure radiated forward (at 0°) averages about 25 times greater than pressure radiated 60° or more off axis. At 50 Hz, however, pressure is much closer to equal in all directions, off by only about 30 per cent even behind the speaker.



Flat frequency response in the anechoic chamber is lost in the living room: The top drawing shows stylized radiation patterns—one at a low frequency, the other at a high frequency—for a loudspeaker in an anechoic chamber. The patterns coincide on the forward axis; thus the speaker's frequency responses are equal at those frequencies and in that direction. As a first step toward simulating a listening environment more typical than an anechoic chamber, a wall is built in the chamber behind the speaker (bottom drawing). Since the high frequency does not radiate appreciably behind the speaker, its pattern is virtually unaffected. But the low-frequency radiation reflects off the wall, doubling the frequency response at the low-frequency end.

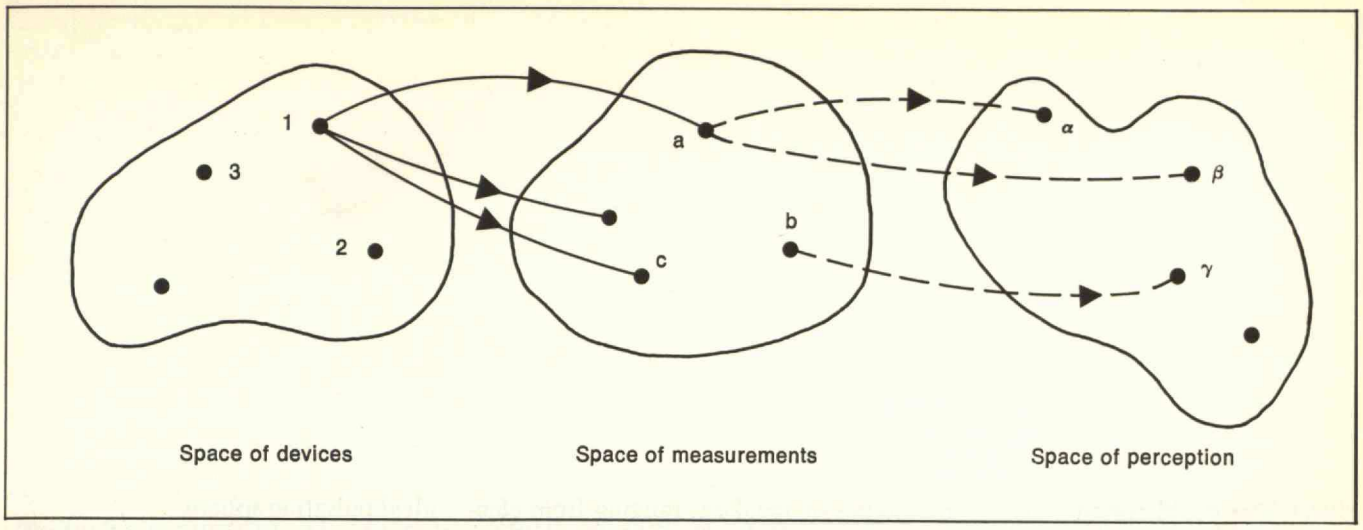
measurements are optimized. However, they have seldom investigated the relation between the measurements and perception. In other words, the correlations between physical devices and measurements, indicated by the lines joining points in space 1 to points in space 2, are well established, but there has been relatively little work done to correlate measurements (points in space 2) to the perception of music (points in space 3). Without correlations to perception, the value of measurements made on devices, and the value of designing devices to meet certain measurement criteria, are subject to serious question. To take a simple example: consumers in today's high fidelity market are paying premiums for engineering that tries to optimize measurements that are already below the threshold of audibility. Further lowering of the measurements serves only to improve the performance read from a meter and raise the price. But human hearing cannot detect the improvement in the measurement.

The problem of establishing correlations between points in the measurement space and points in the perception space is deeper yet. There is no reason to believe that useful correlations can be established between measurements and perception when we start with points in the measurement space that were selected only because they represent physical measurements that are convenient to make. Other physical measurements, yet to be discovered, may be more closely related to perception.

Let's look now at another fundamental problem. Consider a space of sounds, in which different points represent sounds that are perceived to be different. Let a point L represent the sound a listener would hear at a certain live performance of music in a concert hall, for example. Then let S_1, S_2, S_3, . . . represent sounds the listener hears produced by different music reproduction systems in his home when he plays a recording that has been made of the performance.

Two salient characteristics of this space are readily established. First, we do not expect to exactly reproduce in the living room the sound a listener would experience at the live performance. There are many factors which preclude this exact reproduction. Prime among them is the living room's small size compared to the concert hall. All sounds produced in a living room bounce around with times between reflections that are very short compared to those of the concert hall. And this difference is easily perceptible.

The second important characteristic of the space of sounds is that we know of no way to establish a measure on it. That is, we know of no way to measure the magnitude of the difference between two points representing two different perceived sounds. In fact, we are a long way from even having a set of measurements that is sufficient to characterize all the different sounds that we can perceive. One can make many measurements on different sound waveforms, but we do not know of any set of measurements that can always predict whether people can detect the difference between these sounds, let alone predict whether a person will judge that sound S_i or S_j is closer to L. We conducted many experiments with professional musicians, and all this became quite clear. A good musician can easily identify different sounds—for example, the sounds S_1, S_2, and S_3 produced by different music systems that are playing the same recording. However, assuming that the systems are reasonably



good, a strange result will occur when you ask the musician which system is the most accurate—which of the points S_1, S_2, and S_3 is closest to L in the space of sounds. One musician in our experiments commented: "I can distinguish between the systems easily, but I cannot say which is more like the live performance. It's as if you asked me whether a peach or a grapefruit is closer to a lemon. The peach has more the size of the lemon and the grapefruit has more the appearance of the lemon."

If we do not have a measure on the space of sounds and we cannot reach the perfection of recreating the concert hall performance in the home, then we must ask: How close can we come to our goal? Without knowing how to measure the distance to exact reproduction, we could work forever without realizing that we might already be as close as we can get to this goal.

Difference Experiments

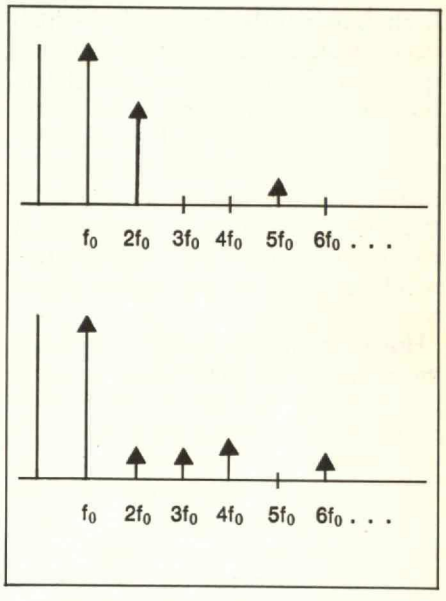
By 1959 we were at a low point on our curve of knowledge vs. time. We recognized many fundamental problems and we understood what was wrong with existing methods of speaker design, but we had no constructive approaches to offer. In fact, we were about to open our parachutes and abort the research program.

Coming from mathematical disciplines into a discipline like this where everything seemed soft . . . it just didn't appear that we could get a handle on it. We didn't want to muddle through by asking people their opinions and finally creating a system that one particular person or a group of people happened to like. We wondered whether we could do anything scientific. We knew we couldn't find out which loudspeaker was best, but could we determine ingredients of speakers that would contribute to more accurate reproduction of music?

Pursuit of that approach proved very fruitful. If we properly limit the questions we ask, we can indeed gain much useful information about various design parameters and their correlation to perception. In fact, as we shall see, we can even determine the limits for optimization of different design parameters beyond which there is no audibly perceptible change in performance.

The key that enabled us to obtain this valuable knowledge is a basic concept in psychoacoustic testing which we shall call a "difference experiment." In these experiments, listeners are given a sequence of two musical signals differing at most in only the one parameter under investigation. The listeners are asked to indicate only whether they can detect *any* difference between the first and second signals of the sequence. By arranging an ensemble of these sequences in which the first signal is common to all and the second is sometimes identical to the first and otherwise is identical except that the parameter under study has been altered, one can readily determine the range of audibility of the given parameter.

Let's take a very simple case and see what can be learned. If all the knowledge we now have about the hearing process were erased, one might arbitrarily decide to design a HiFi system with a frequency response out to a megahertz. How could one learn that was not necessary? (It could get pretty expen-



A way to visualize the fundamental nature of problems involving devices, measurements, and perception. Lines connecting points in the space of devices to points in the space of measurements represent specific measurements made on specific devices. Points in the space of perceptions represent perceptibly different processing of the same signal by different devices. Measurements do not always correlate uniquely with perception. One common measurement (symbolized above by a) is made by presenting a sine wave at some frequency f_o to a device, which, in processing the signal, introduces distortion. A notch filter removes the f_o component from the output. The waveform that remains is the distortion. The ratio of its RMS amplitude to the RMS amplitude of the input constitutes a measurement of "harmonic distortion." But the distortion can be divided in perceptibly different ways among the harmonics of f_o; the illustration immediately above shows two possible distributions of harmonics yielding the same measurement of harmonic distortion. Measurements have often been selected because they were convenient. There may be other measurements, as yet unknown to us, with significant relations to perception.

sive.) One could conduct an experiment in which listeners are given one music signal with a one-megahertz bandwidth, and another which was identical except that all frequencies above a chosen cutoff frequency were removed. If the cutoff frequency is set at 5 kilohertz, listeners would immediately be able to distinguish the second sample from the first, providing, of course, that the music sample contained instruments playing in the higher registers.

However, if the cutoff frequency were set at 20 kHz using a sharp cutoff filter, the experiment would reveal that listeners could not tell the difference between music signals with a 1 mHz bandwidth and a 20 kHz bandwidth. In a similar fashion, we can gain very valuable, and sometimes very surprising, information about many other parameters. In all these experiments, great care must be taken to ensure that the only parameter that changes in the sample set is the one under study. This may be obvious, but historically it has been the cause of many erroneous conclusions—several parameters change but the experimenter makes conclusions about just one of them.

The Ideal Pulsating Sphere

The concept of a "difference experiment" can be used in much more sophisticated situations to yield very significant information about speaker design. One such experiment occupied our research efforts from 1960 to 1964.

There has always been a great deal of mystery and controversy associated with the choice of methods of converting electrical energy into acoustical energy. Articles have appeared claiming benefits for various types of speakers, ranging from electromagnetic through electrostatic to ionic units. It has been common belief, though, that none of the methods could produce music in a room as purely as could the unrealizable "ideal pulsating sphere" cited in acoustics studies. This ideal sphere is, by definition, a theoretically perfect moving surface that has no resonances or distortion and that launches a sound wave that is an exact replica of the electrical waveform that is its source.

However, experiments we had conducted from 1956 to 1960 indicated that this common belief might be in error. We thought it might be possible to construct on a spherical surface an array of small full-range speakers that would (with appropriate contouring of frequency response by means of electronics) reproduce music which would be subjectively indistinguishable from that which would be reproduced by the ideal pulsating sphere. But how could we prove or disprove this since the ideal sphere is something that cannot be constructed? This was the subject of our work for four years, and a difference experiment was instrumental in resolving the issue.

Of course, if we had access to an ideal sphere we could perform our experiment by making recordings in a room, first of the ideal pulsating sphere's performance and then of the real spherical array of speakers playing the same musical selections. We could then have the recordings played over high-quality headphones and make the standard "A-B" comparison tests to see if listeners could distinguish between the two recordings. The procedure would be relatively straightforward—but we obviously do not have access to an ideal pulsating sphere.

However, with the aid of a high-speed digital computer—the TX-2, designed by the M.I.T. Lincoln Laboratory—we were able to obtain recordings of the sound that an ideal pulsating sphere would produce in a given room. These recordings were then used in the comparison tests with our array of speakers.

A few words about how the computer was used to produce the recordings of the ideal sphere: Since the propagation of sound in a room—even at the highest listening levels—meets certain conditions (mathematically speaking, meets the requirements for linearity), we could use the techniques of linear system theory to obtain our desired recordings. In particular, if we knew only the response of a linear system to a narrow pulse, then we could calculate the response of that system to any input. The mathematical operation by which the response is calculated is called convolution.

Thus we needed only to construct an acoustical source which could produce the same pulse as would be produced by the ideal sphere. The recording of this pulse in a room would then enable us to calculate the response of an ideal sphere in that room to any music or speech signal.

After trying many sound sources, we finally determined that an electrical spark discharge would meet all the conditions required for our experiment. Thus, a spark was set off in a room in a position where the ideal sphere would have been placed. The acoustical result of this spark was recorded through a microphone placed about ten feet back in the room. This recording was sampled 30,000 times a second, converted to a digital signal, and stored

in the TX-2 computer, where it was convolved with music and speech sources that were later fed to the computer. The computer thus became a sort of HiFi—it produced audio tapes identical to what the microphone in the room would have recorded if the music and speech samples had been played in that room through an ideal pulsating sphere. In this way, we obtained recordings of a range of music and speech as played through the ideal sphere—without ever having the sphere.

While this experiment is simple in concept, the experimental difficulties were enormous. Moreover, the experiment required extension in the computer programming knowledge existing at that time. One computer programmer had originally estimated for us that it would take hours of computer time to produce one second of music. Professor Thomas Stockham developed a program which was dependent upon the data in a way that shortened the computation time to seven minutes per second of music. Without his program, the experiment could not have been conducted.

The results of this four-year difference experiment were presented to a joint meeting of the Institute of Electrical and Electronics Engineers and the Audio Engineering Society at M.I.T. in November, 1964. The conclusion was that no one could tell the difference between the performance of the array of small full-range speakers on the spherical surface and the computer simulation of the performance of the ideal pulsating sphere.

Two very basic results were established by the experiment:

□ The experiment proved that, as far as quality of reproduction is concerned, we need not look beyond a multiplicity of full-range cone speakers, since they are capable of reproducing music and speech signals that are subjectively indistinguishable from those reproduced by the ideal pulsating sphere. Thus the search for other methods and materials for more accurate music reproduction could be ended. While it might be possible for other transducers to do as well as the multiplicity of cones, they could not do audibly better.

□ Since the ideal pulsating sphere has, by definition, no audible distortion, and no audible irregularities in frequency response, transient response, or other responses, the experiment proved that the measurable irregularities of the array of full-range cone speakers did not contribute any audible coloration to the reproduced signal (since that signal was subjectively indistinguishable from the performance of the ideal sphere).

We were quite pleased with the knowledge we had gained from this experiment. But we were shocked by a totally unexpected result: The spherical array of speakers still exhibited objectionable shrillness on ensembles of violins and wind instruments playing in the higher registers. We had always thought that shrillness like that I had heard when I purchased a loudspeaker in 1956 was associated with either distortion or frequency response irregularities. Now, for the first time, we realized that it was not caused by any of the parameters we normally measure in loudspeaker design, because the spherical array sounded identical to the ideal pulsating sphere—which, of course, had no irregularities in any of the normally measured parameters. There had to be other dimensions to speaker design and measurements that we had not yet discovered.

(First of a two-part article. The conclusion will appear in Technology Review *for July/August.)*

Edward E. David, Jr.
Executive Vice President
Gould, Inc.

Energy: A Strategy of Diversity

One of the principal features of our times is the strong interaction of political-social and technical factors in determining the future. Another is the wide divergence of the many factions and viewpoints in our society which represent either self-interest or doctrines whose supporters consider them sacrosanct. These divergent elements must be reconciled before progress on the so-called problems of society becomes feasible. Unless such reconciliation takes place, technological success can turn out to be political or social failure.

The energy situation is a case in point. Technology is not the primary barrier to solving our energy problems. Rather, that barrier is the often-noted collision between energy and the environment, between energy and economics, and between energy and societal values. Energy is tied up with the life-style argument, with moral judgments, and of course with changing societal values. These create constraints which can preclude any particular technological contribution. A corollary to this thesis is the following: high technology will not play the central role in assuring our energy supply that it did in the space and military programs of the 1960s. A different strategy is called for—one in which federally-funded research and development will play a lesser role and in which the single-minded federal agency is not a feasible approach.

There are large stakes in the "energy crisis." Energy is a bona fide and credible challenge to the nation. It provides a focus for effort on a national scale. The challenge is to our national well-being. For example, it has been predicted that oil and gas imports by 1980 will amount to almost $30 billion. Total U.S. imports of all goods and services last year were only some $50 billion. Thus energy imports will severely aggravate our balance-of-payments problem in the coming decade. Furthermore, this money will go largely to the Middle East where it will constitute the greatest accumulation of foreign exchange funds in modern times. This situation will be worsened by the purchases of Japan and the European nations. The potential of such huge monetary power for mischief or even reinvestment in the West could make the recent monetary crisis and Jean Jacques Servan-Schrieber's "American Challenge" to Europe seem mild by comparison. This is only one of the stakes in the energy game. Others involve the nation's environment, its life-style, and its standard of living.

So there is little wonder that we see Senator Henry M. Jackson and other prominent legislators proposing programs to address the situation. Senator Jackson's proposal is for a $20 billion research and development program to make the U.S. self-sufficient in energy by 1982.

This proposal is strangely reminiscent of Apollo. Is this a feasible goal? Is a technological fix possible, as it was when we were confronted by Sputnik in 1957 and by the missile gap of the early 1960s? To see if Senator Jackson's goal is likely of achievement, let us examine what technological directions are being set for the next 10 years and how their effectiveness is likely to be eroded by political, social, and economic considerations.

Clean Fuels, New Fuels, New Sources

There is no lack of embryo technological resources.

First, consider the potential of revitalized geological exploration for new energy resources. There are a number of proposals for encouraging more exploration for fossil fuels through economic incentives such as gas price deregulation and accelerated leasing of federal tracts. Technologically, there are promising new developments in data processing and interpretation of geophysical records. World-wide computer processing networks are being set up to make these techniques widely available to aid exploration. There have been advances in the geological understanding necessary for the interpretation of such records. Certainly this inferential science will progress, thereby decreasing the risks and increasing the pay-offs of exploration. This should build the nation's domestic reserves in the years ahead.

Private industry is learning how to extract more fuel from existing fields. Secondary and tertiary extraction methods now being developed promise to substantially increase the current 30 to 35 per cent recovery fraction, which is set by economic limitations.

Perhaps the most significant technological direction is toward derived or synthetic fuels to replace other forms such as natural gas and low-sulphur oil. This effort aims par-

Edward E. David, Jr., joined Gould,Inc., as Executive Vice President (and President of Gould Laboratories) early this year, following three years' service as Science Adviser to President Richard M. Nixon. Dr. David studied electrical engineering at M.I.T. (S.M.1947, Sc.D.1950) and in 1952 joined Bell Telephone Laboratories, Inc., where he was Director of Research in the Communications Systems Division when called to the White House. This paper is the slightly revised text of his address to a Highlight Session of the Institute of Electrical and Electronics Engineers in New York in March, 1973.

The stakes in the "energy crisis" and in the longer-range future of U.S. energy supplies are high indeed. But a coalition of forces and policies—not a monolithic technological attack—is the only appropriate response.

ticularly at cleaning dirty fuels. Coal is the main target, for the nation's reserves here can be measured in hundreds of years. The U.S. alone has 390 billion tons of reserves that are commercially recoverable under present economics and present mining practices. Last year U.S. production was less than one billion tons, so our supplies are not being diminished very fast. In cleaning coal for use in today's world, sulphur and particulate matter are the major targets. It turns out that these are by far the most damaging pollutants to health and property.

There are various processes for synthesizing clean fuel from coal. Beginning on the precombustion side, pyritic sulphur can be removed chemically through a process which has been demonstrated at the pilot level. Furthermore, the costs of this treatment do not add significantly to the cost of the energy produced. Assuming successful removal of pyrite from coal makes a considerable addition to the coal reserves of the country which are usable within the demands of the Clean Air Act.

However, at least 50 per cent of our coal contains sulphur bound chemically rather than appearing physically separate as pyrite. These coals, as well as lignite, peat, and other hydrocarbon fuels, can be transformed into liquid or gaseous forms which are inherently clean. The processes are more complex and more expensive than that for pyrite removal. A typical and very promising process is solvent refining; as the name implies, coal is first dissolved in a reagent which is then treated chemically to precipitate the sulphur. A privately-built pilot plant will be on-line some time in 1973 and a federally-sponsored one in 1975. No demonstration-size plant is yet planned. There are several other coal liquefaction processes which show promise.

Coal can also be turned into a clean liquid or gaseous fuel through various processes, and three pilot plants are either in operation or nearly so. Furthermore, some of these processes could yield fuel in significant quantities by the early 1980s. Precombustion treatment of coal and gasification have the advantage that the resulting synthetic fuels can be burned clearly in current installations with at most minor modifications.

Related to coal gasification and liquefication are new methods of combustion in which the pollutants are bled off before they can reach the environment. Needless to say, special combustion chambers are necessary for all these methods, so this new technology will be mainly applicable to new installations, though retrofits are possible in some instances.

After combustion, stack gases can be to some degree cleaned of their pollutants, especially of sulphur oxides. A number of pilot plants demonstrating various techniques of stack-gas cleaning now exist. There are still technical problems with this approach and, in addition, disposal of the resulting waste constitutes a major problem.

It has been known for many years that clean fuels can be obtained from unconventional sources such as oil shale and tar sands. There are vast oil reserves locked up in shale in the western United States, perhaps more than in the Middle East reserves, and there is also natural gas similarly impounded by nature. There are substantial petroleum reserves in the tar sands of Canada and the other Americas. The technology to extract these resources can surely be developed. Small-scale efforts are going on today, and work on tar sands is reaching the commercial stage; but oil shale and tight gas formations are not yet economically competitive.

This is a quick review of the technologies available in a 10-year time frame to increase the nation's supply of clean fossil fuels. Will they be used and to what extent? Can they help meet Senator Jackson's goal?

There are contradictions which cast serious doubt.

Dilemmas and Frustrations

In order to use the nation's coal reserves, they must be mined economically. Needless to say, there are environmental objections. Indeed, there are several bills now in Congress to prohibit strip mining or add substantially to the cost of its product, and most would seriously reduce coal production. The forces behind these bills seem not to be interested in new reclamation techniques or in ways of securing adequate resources with minimum damage but rather with prohibitions and inflexible rules on one hand in contrast to unrestricted license on the other. Underground mining is similarly afflicted with regulations from the Mine Health and Safety Act of 1957. These and similar restrictions could prevent us from economically using our coal reserves despite the existence of technology for cleaning them.

The same is true for oil shale. "Good" shale provides about two-thirds of a barrel of oil per ton of shale. Thousands of tons of shale per day must be handled to supply significant amounts of oil, and the residue of retorted shale must be disposed of in an acceptable way. Yet

A detailed summary of the specific programs is attached. The highlights of the President's energy R&D program follow.

Coal. The President's FY'74 budget includes a 27% increase to $120 million for coal R&D - or a 300% increase since 1970. Additional funds to be requested would further increase this level. Major programs at the Department of the Interior to expand the use of coal in a manner compatible with the environment are:

-- liquefaction and precombustion removal of pollutants.

-- high BTU coal gasification to produce pipeline quality gas.

-- low BTU coal gasification for industrial and utility use.

Nuclear Fission. The FY'74 budget provides for a $63 million increase for AEC's nuclear fission R&D programs.

Highlights are:

-- a $51 million increase to maintain the pace of the Liquid Metal Fast Breeder Reactor program toward the goal of commercial demonstration by 1980.

-- an 11% increase in R&D to further ensure the safety of the current generation of light water reactors.

Nuclear Fusion. The AEC's thermonuclear fusion program is increased 35% to $88 million in the FY'74 budget. This program includes:

-- a 19% increase to develop controlled thermonuclear fusion reactors through magnetic confinement.

-- a 59% increase to develop the capability to initiate a thermonuclear reaction using a high powered laser.

Solar Energy. The solar energy program would triple, from $4 million in FY'73 to $12 million in FY'74. The program will be administered by the National Science Foundation and emphasize the development of solar energy for:

-- heating and cooling of buildings.

-- producing and converting organic materials to fuels.

-- generating electricity.

Additional Environmental Control R&D. In addition to the substantial efforts to develop cleaner fuel from coal, the FY'74 budget provides for a 24% increase, from $38 to $47 million, for other environmental control research with expected near-term benefits. This includes a construction of the TVA demonstration SO_x removal plant as well as continued R&D aimed at minimizing the thermal effects of power plants.

Other R&D Programs. Other energy R&D programs include:

-- an accelerated effort in utilization of geothermal energy.

-- development of magnetohydrodynamic (MHD) devices, in cooperation with the Soviet Union, to produce electric power more efficiently from heat.

Electric Utility Participation. The President also cited the importance of non-Federal energy R&D and noted with pleasure the formation of the Electric Power Research Institute. He indicated that this utility R&D organization, with a budget in 1974 exceeding $100 million, would provide additional capability to accelerate and influence the development of energy technology. The President also urged all State utility commissions to consider permitting increased R&D expenditures to be included in utility rate bases.

When President Nixon released his "energy message" to the Congress on April 18, the Office of the White House Press Secretary provided a supplementary "fact sheet" which contained the summary shown above of energy research and development in Mr. Nixon's budget for 1973-74. In the "energy message" itself, President Nixon told the Congress that the 1973-74 budget proposals for energy studies were in fact 20 per cent over funding levels of 1972-73. And, he said, "it is foolish and self-defeating to allocate funds more rapidly than they can be effectively spent. . . . When additional funds are found to be essential, I shall do everything I can to see that they are provided."

shale swells during treatment so there is in fact more volume of waste than of the original oil shale. This waste poses a major disposal problem.

There is also resistance to the use of underground nuclear explosions to release trapped gas.

What about nuclear power? Today we have boiling and pressurized water reactors, and we will soon have gas-cooled reactors. But requirements of the National Environmental Protection Act and other siting impediments mean that there is currently an eight-year lead time in constructing nuclear plants. There is also a controversy about the safety of nuclear power plants and about whether their wastes can be disposed of responsibly. Looking forward 10 years, technology will improve nuclear safety and can, I believe, solve the problem of radioactive waste disposal. However, the technology upon which construction of breeder reactors depends will only be coming of age by 1982.

Energy conservation is another route to easing our energy shortage which might be effective in Senator Jackson's time-frame. In striving for increased efficiency of energy use, we encounter a fundamental natural limitation as well as societal and political ones. The former arises from the laws of thermodynamics, which place basic restrictions on the efficiency of power generation. Today the efficiency of power generation from fuel to electricity is at best about 35 per cent, and the fundamental thermodynamic constraints mean that this efficiency cannot be increased in a major way. Yet electricity is the fastest-growing segment of energy usage: it is estimated that 50 per cent of the total raw fuel consumed in the U.S. by 1980-85 will be for generating electricity. This means that approximately two-thirds of the energy available from 50 per cent of our raw fuels will be discarded as heat in the electric generation process. Clearly the use of oil and gas directly as fuels for heating is more efficient.

All heat engines, including those in automobiles and aircraft, are subject to the thermodynamic laws. Thus the production of hydrogen as fuel by electrolysis runs into this same objection. It is significant that the sum of electrical and transportation usage will constitute about 75 per

cent of our total raw fuel demand by 1980. Direct conversion of fuel to electricity through fuel cells and other techniques does not appear to be feasible on a large scale in the 1980 time frame. All this suggests that the efficiency of our energy use can be increased by only a small factor in the next decade.

This is not at all to say that we should not strive to take conservation steps, but such steps will be more pointed at changes in life style than in new technology. For example, perhaps an effective measure on the consumer front would be for appliance manufacturers to indicate not only the first cost of their equipment but also its operating cost over its lifetime. With this information available, the consumer could better choose the trade-off between these two costs. Such a step implies a change in the public's buying habits rather than the use of new technology.

Energy conservation is contravened by many of our current laws and regulations— for example, the Clean Air Act and our transportation safety regulations. Today's cars use much more fuel than yesterday's did; it has been estimated that 1973 models use 30 per cent more fuel than 1968 models. Increased weight of cars, at least partly due to safety factors such as side rails and safety bumpers, is a large factor here. The decreased compression ratios and decreased burning temperatures of modern engines decrease their efficiency. The lower compression ratios are necessary because of the removal of lead from gasoline to protect the oxidation catalyst contemplated for 1976 automobiles, and because of questions about the health effects of emitted lead, especially on children in the cities. The lower burning temperatures are due to exhaust gas recirculation to control emissions of oxides of nitrogen.

Toward Renewable Energy

All of this means to me that there is but slight chance of the U.S. being independent of foreign sources of fuel by 1982. Throwing research and development money at the problem in the Apollo fashion will not help. The situation is simply not analogous to the Apollo program where progress and the rate of research and development expenditures were closely related. There technological progress was the essence of progress toward the goal. In the case of energy, technological progress can be quite oblique due to constraints of environment, capital resources, and social forces. Rather than being the driving force, research and development is a coordinate force along with many others, particularly in the 1982 time-frame.

If the nation cannot achieve fuel independence by 1982, when can it? By 1992? By 2002? Any answer is purely speculative, but the general technical direction seems clear enough. To achieve true independence, the nation's energy supply must not be based upon nonrenewable resources but upon those which are steadily replenished or easily replenishable.

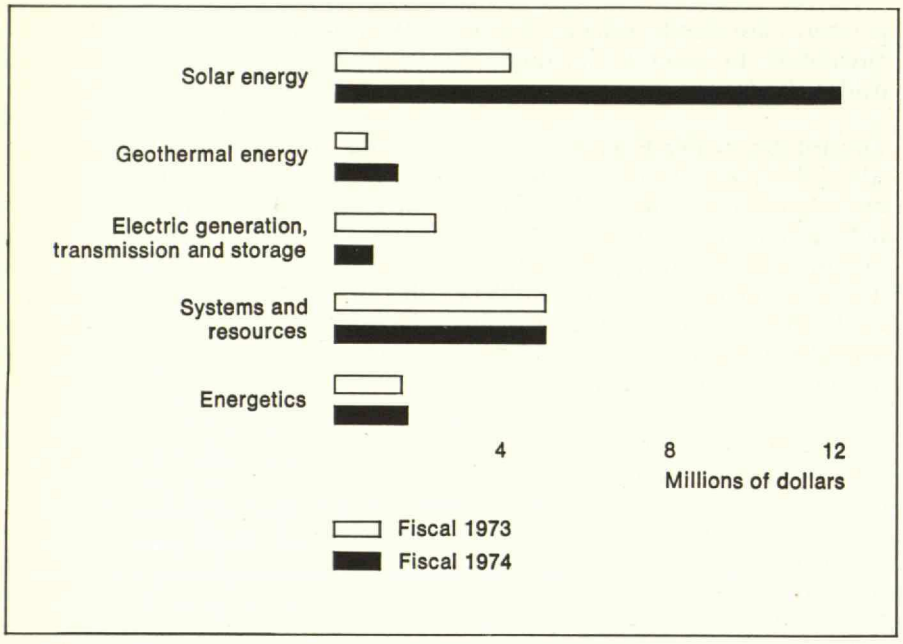
I say this though there is no present world shortage of hydrocarbons, and though I do not believe that a model which proposes drastic limits to future growth is an accurate reflection of reality. But hydrocarbons are becoming too valuable as petrochemical resources to be burned, and I believe it is clear that political and economic forces will strongly tilt our future energy supply toward renewable resources.

What technology is available in the longer time frame, and in particular for renewable resources? Breeder reactors (the liquid metal fast-breeder reactor, the fast-gas reactor, and the molten-salt reactor) are almost in the renewable category, for they extract perhaps 25 times as much energy from a pound of uranium or thorium as do current reactors. Technology is likely to make their construction possible in the 1980s. However, there are psychological barriers to the widespread installation of breeders arising from the safety and waste disposal problems that I mentioned earlier. In addition, there is the difficulty of controlling the disposition of the large amounts of plutonium fuel—potentially a nuclear explosive—created in and for the breeders.

There are three other principal candidates for energy sources based on renewable resources. These are geothermal, solar, and fusion.

Geothermal is already being tapped in a limited way for power production in California. The total resource base of geothermal steam is not well established, though there is known to be a great deal in California's Imperial Valley. It is also clear that many hot water deposits occur at too low a temperature to be used efficiently for the generation of power. However, there are new ideas in the offing. Dry hot rock underlies much of the U.S., and proposals have been made to inject water into these formations and obtain steam in return. Such schemes have not yet been tested but certainly should be.

Solar energy is controversial. Some people feel it will become the major resource. But there are fundamental difficulties tied up with the fact that, though solar energy is large in



The National Science Foundation has $21.5 million of the federal budget for fiscal 1974 to be spent for energy research and development; this compares with $14.2 million in the current fiscal year. N.S.F. will make major new research investments in two renewable energy sources—solar and geothermal.

amount, it is distributed diffusely over great areas and is difficult to concentrate. The fact that solar energy is intermittent means that some form of energy storage will be required in many applications. There is good research work going on in the solar field. There are greenhouse films to create high temperatures and proposals for space stations to overcome the intermittent nature of sunlight on the earth's surface. Small solar installations for heating and cooling individual homes and buildings are feasible today, and it is not inconceivable that solar energy could in the future provide a substantial part of such home needs.

Thermonuclear fusion is potentially a major energy resource. There are two current approaches. In the first, an ionic gas is contained in a magnetic field at a sufficient density and for enough time to generate net power. This approach has been dragging on for 25 years, but researchers are now beginning to understand enough of the complex plasma processes involved to give reasonable assurance that they can design a machine on which a break-even experiment could be demonstrated. There is heavy federal financing for this work and the Atomic Energy Commission's current best guess as to schedule calls for break-even in 1978 and reactors by the year 2000. There are similar efforts in the U.S.S.R and Western Europe.

Against this backdrop there is a new approach to fusion that uses high-powered lasers. Here a pellet of deuterium and tritium or of deuterium alone is irradiated by a short laser pulse, creating a miniature thermonuclear explosion. The energy is captured and used to generate electricity. This approach has not been demonstrated, but the estimates of the power required in the laser pulse have come down to between 1 and 25 kilojoules per pulse from a much higher value a few years ago. Neutrons have been produced from irradiated targets, but there has been no ignition of the fuel. Work in this field is moving forward in the U.S.S.R. and at A.E.C. laboratories, and there is work in this country in the private sector which is of interest and appears significant. Some workers in the laser fusion field predict a break-even experiment this year or next, but these predictions are controversial. However, I am encouraged by the competition in the field and expect to see results sooner rather than later.

A Strategy for Independence

Returning to Senator Jackson's ambitions, when can we expect liberation from the tyranny of dependency on nonrenewable energy sources?

I believe we could be on the way in 20 to 25 years. It may well be that Japan will show the way in actually achieving the goal, for the Japanese have even more incentive than we—and they have large financial resources for investment and large-scale experimentation.

But the U.S. cannot afford to dally in this matter of energy supply, and that is well recognized in the federal government. What is being done? What is the approach and who are the players?

The federal energy strategy as laid out in the President's Energy Message to Congress of June 4, 1971, called for both technological and

non-technological measures, including accelerated leasing of off-shore oil and gas tracts and of geothermal resources in the West. On the technological side, the message proposed increased effort on the liquid-metal fast-breeder reactor, on the gasification of coal, and on stack gas cleaning. This program has gone forward and a new energy message has now been sent to the Congress. This message proposes gas price deregulation to spur domestic exploration and eased oil-import quotas to allow adequate flow of foreign oil into the country. The technical strategy remains unchanged: in the short range there will be emphasis on coal and uranium in conventional reactors; in the middle range (1980 to 2000) on breeder reactors; and in the long range on fusion, solar, and geothermal sources.

This strategy is not without opposition from the political and social forces to which I referred earlier. In addition, it is complicated by the commercial nature of the resulting developments. The energy machinery must be produced, sold, maintained, and operated largely by private industry. The conflict with federal funding is obvious. The current approach to avoid the accusation of a federal give-away is that of cost-sharing between industry and government. This is coming to be an important way of proceeding.

On the federal side, energy research and development is centered in the Atomic Energy Commission and in the Interior Department; the latter's new energy section, including the office of Coal Research and elements of the Bureau of Mines, is backed by a $25 million fund. The National Science Foundation is sponsoring work in both industry and the universities, as are the Defense Department and the National Aeronautics and Space Administration. The sum total will amount to between $600 and $700 million in 1973-1974. In the White House there is a new energy group headed by Charles DiBona. This group reports to Henry Kissinger and George Shultz, which is appropriate since energy touches on domestic, foreign, and economic affairs. This group is policy-oriented.

On the industrial side, there is the Edison Electric Institute and its newly-created Electric Power Research Institute. Its budget is $80 million and increasing. Manufacturers of power equipment spend perhaps $100 million, and the gas and oil companies spend at least that much more.

There are perhaps other players, but this recitation covers the major dimensions, except for the universities which are becoming a major resource for all elements.

This is not a very neat picture. It consists of many diverse elements informally coordinated. It is my contention that this coalition of forces, each maintaining its own identity, is the right one for the "energy crisis."

A key element in this picture is the involvement of industrial financing. The government should encourage more of that. I see some encouraging signs—for example, private proposals for a new uranium fuel enrichment plant. Uranium enrichment services could become a major source of export revenue. Also, the A.E.C. has allowed private financial involvement in the laser-fusion program despite the obvious weapons implications. I would encourage further steps in this direction. The excellence and pace of research and development can be enhanced in a major way by permitting highly-motivated people to innovate—that is, carry developments forward from the laboratory to the marketplace. Thus the N.A.S.A. model—a mastermind government agency—is not a viable one for the coming era of energy research and development, in my opinion.

The necessary technological developments to make the United States independent of foreign sources of fuel by 1982 can be made available, but there is not an adequate political or societal consensus as to their acceptability. Furthermore, independence by 1982 implies a rate of capital investment by the private sector which is beyond any prudent estimate. Infusion of large research and development funding will not alter this situation. The federal government now spends $600 million per year, and this might grow some as programs mature; but this general level is not far off the mark, in my opinion.

In the longer time frame, independence hinges upon the use of renewable resources and the accompanying technologies of breeder reactors and fusion, with perhaps some contributions from solar and geothermal technologies. Bringing these into being in the next 25 years and within economic feasibility calls for private industrial initiative, heightened by federal incentives. This approach is fortunately beginning to emerge, but it must be strongly reinforced in the next ten years. A realistic goal for that time-frame is a vigorous privately-funded energy research and development program of a size at least equal to the federal program.

This is a profound challenge for both industry and government.

Daniel J. Fink
Valley Forge Space Center
General Electric Company

Monitoring Earth's Resources from Space

On July 23, 1972, the first Earth Resources Technology Satellite—ERTS-1—was successfully orbited. Two days later, it began its year-long mission of collecting data about the surface of the earth. Photography during manned Gemini and Apollo had hinted at the importance of remotely sensed data from space. The ERTS Program represents the first space mission solely dedicated to the development of practical applications of space data toward better monitoring and managing the resources of the earth.

Unlike most experimental space programs, in which very small technical groups, perhaps even single investigators, conceive the experiment, design the payload, and analyze the resulting data, the ERTS system was considered to be a facility available to all qualified users. And when the National Aeronautics and Space Administration (N.A.S.A.) solicited proposals from the scientific, industrial, and governmental communities for investigations which might lead to beneficial applications, the response was overwhelming. More than 700 written proposals were submitted. After evaluation, more than 300 of these proposals were selected as potentially both beneficial and practical, considering the kind of data that would be received from ERTS. ERTS data will be used by at least 334 investigators, this number representing "principal investigators" who are under contract with N.A.S.A., and foreign investigators—more than 100 scientists representing universities or other agencies in nearly 40 countries—who have established international agreements with the U.S. and who receive ERTS data directly from N.A.S.A. The number of co-investigators, secondary users, etc. is unknown. Of those 334 principal investigators, 83 are working on mineral resources, geological structure, and landform surveys; 62 on agriculture/forestry range resources; 45 on water resources; 40 on land use surveys and mapping; 37 on environmental studies; and 29 on marine and ocean surveys.

At this date, most of these investigators are in their laboratories, offices, and computer facilities, or at their field sites, engrossed in analysis and checking of ERTS data, correlating what they are finding with other information. In short, they are in the middle of it all. Nevertheless, many positive results have already been achieved and reported at recent meetings and symposia. On pages 34 through 39, we show a few specific applications, accompanied by the relevant views of the earth from ERTS-1.

Daniel J. Fink is Vice President of the General Electric Company and General Manager of its Space Division in Valley Forge, Pa., which has been a major participant in Apollo, Skylab, and many satellite programs. Mr. Fink received his S.B. and M.S. in aeronautical engineering from M.I.T. After graduation, he was associated with the Cornell Aeronautical Laboratory, Bell Aircraft Corp., and Allied Research Associates. From 1963 to 1967, he was first Assistant Director, and then Deputy Director, of Defense Research and Engineering in the Office of the Secretary of Defense.

Images of the Earth

The overall ERTS system consists of a satellite observatory with its unique sensors, and a ground data-handling system that operates the spacecraft and begins the processing of the sensor data received from the spacecraft. Extensive use is made of N.A.S.A.'s space tracking and data network facilities for spacecraft command, telemetry, and tracking functions. Responsibility for the overall system design as well as the design, fabrication, and testing of the observatory and the design, installation, and checkout of the ground data handling system have been contracted by N.A.S.A.-Goddard Space Flight Center to the Space Division of the General Electric Company.

The acquisition of images of the earth's surface utilizes two rather different sensor systems. The first—the Return Beam Vidicon (R.B.V.) System—developed by Radio Corporation of America, consists of three individual high resolution television cameras, each fitted with an appropriate spectral filter. One camera senses the visible blue-green region of the spectrum, a second the visible red, and a third the near infrared. Since all this is reflected solar energy, the cameras can be operated only during the daylight portion of the orbit. All three cameras are mounted on a common baseplate for mechanical stability, and are focused on a 185-kilometer-sided square of the earth's surface directly below the satellite. The three cameras are shuttered simultaneously, storing the earth's image on the photo sensitive face plates of vidicon tubes. Each camera is then sequentially read out by scanning its faceplate with an electron beam to produce a video output signal of 3.2 MHz bandwidth. After readout, which takes about 3.5 seconds for each camera, the photo sensitive surface is prepared for the next exposure. The cameras are reshuttered after 25 seconds, during which time the spacecraft has moved about 165 kilometers along its earth track; thus sequential images of the earth will overlap in the along-track di-

An earth-monitoring satellite's year-long mission is producing millions of images of our planet. It is a pilot project, but the usefulness of its data is already evident.

rection by about 10 per cent.

Exposure control of the cameras is commandable from the ground in five exposure-time steps ranging from four to 16 milliseconds, to allow for variations in earth surface illumination and average reflectivity. Each of the cameras has a 9 × 9 matrix of 81 reference marks etched in the faceplate of the tube, which aid in the removal of most of the geometrical distortions in the camera system during subsequent ground processing, when images are reconstructed from the video signals.

The second imaging sensor—the Multispectral Scanner System or M.S.S.—was developed by Hughes Aircraft Company. It gathers data by imaging the surface of the earth in four spectral bands simultaneously through the same optical system. This greatly simplifies the problems of registration of the individual spectral images on the ground. A pivoting mirror is used to continuously scan perpendicular to the spacecraft velocity. Six individual detectors are used in each spectral band to overcome signal-to-noise problems. An 80-meter-square instantaneous field-of-view is achieved at a vertical altitude of 917 km. Spacecraft motion provides the along-track progression to accumulate the data to construct images. Photomultiplier tubes are used as the detectors in the first three spectral bands; silicon photo-diodes are used in the fourth band. The detector outputs are sampled, digitized into six-bit bytes, and multiplexed into a continuous data stream at 15 megabits per second.

The active portion of the scan occurs as the mirror images a 185 km. wide trace from west to east below the satellite. During the retrace portion of the scan, calibration and other data to be used later to construct the picture are inserted into the data stream. Data processing on the ground transforms the continuous strip imagery from the M.S.S. into square framed images 185 kilometers on a side with approximately ten per cent overlap between consecutive frames—analogous to those images produced by the R.B.V. system.

The observatory also carries a third payload, but of a totally different type than the imaging sensors. This payload is the Data Collection System (D.C.S.) which relays data gathered by many ground-based automatic data collection platforms deployed in remote locations. Each platform can accept data from as many as eight analog or 64 digital sensors. These may be used for periodically sampling local environmental or surface conditions such as temperature, humidity, stream flow, soil moisture, air quality, etc.

The D.C.S. platforms, once energized, interrogate their sensors, format and encode a message, and transmit it to the satellite once every three minutes. Transmission requires only 34 milliseconds. When the spacecraft is in view of both a transmitting platform and a ground receiving station, the message is relayed immediately to the receiving station through the spacecraft. Otherwise, the message is stored by on-board tape recorders to be transmitted later. The messages received are subsequently sent to individual investigators. Although more sophisticated data collections systems have been designed, such as those which interrogate individual platforms on command, the ERTS D.C.S. has been designed as a simple, reliable system that minimizes the cost of the ground platforms.

Spacecraft and Ground Data System

The ERTS spacecraft utilizes, to the maximum practical extent, designs and hardware previously developed and used in other space programs. This philosophy was instituted to produce an economical, reliable spacecraft, consistent with a two-year implementation schedule from program start to launch. Many of the spacecraft subsystems, as well as the overall structure, are taken directly from the Nimbus series of meteorological spacecraft. The narrowband telemetry, tracking, and command equipment design is derived from Apollo.

The large size, mass, and heat dissipation of the two sensor systems required structure modification to the lower section of the spacecraft as well as unique thermal control design. A new dual wideband telemetry system was required to transmit simultaneously the wide-band data from the R.B.V. and M.S.S. sensors. Two identical but independent wideband tape recorders store data while the spacecraft is outside the field of view of any of the ground receiving stations, of which there are three equipped to receive ERTS wideband telemetry, in Fairbanks, Alaska; Goldstone, California; and at the Goddard Space Flight Center in Greenbelt, Maryland. A new attitude measurement sensor and a slightly modified attitude control subsystem were added to provide data for accurately gridding images with earth latitude and longitude. An orbit adjust subsystem was needed to achieve the precise orbital parameters after launch and to maintain these parameters

(*Text continued on page 40*)

Applications of ERTS-1 Imagery

Classifying Land Uses: (left) At present, land use identification mapping is a lengthy and expensive process which generally fails to reflect all the changes in an area that are of interest to urban and regional planners. Although ERTS-1 imagery is restricted to a small-scale format by resolution limitations, several investigators are demonstrating the utility of ERTS in land use classification.

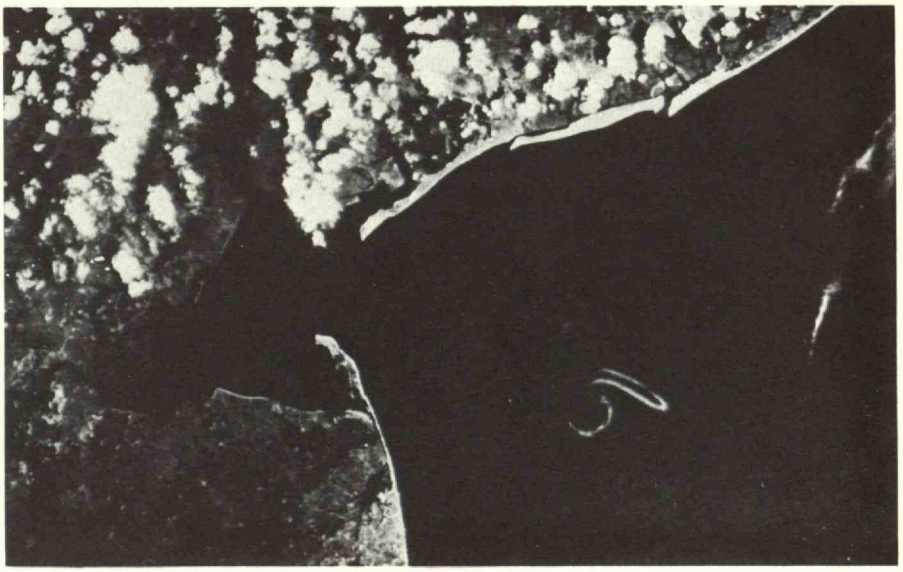
Professor Robert B. Simpson of Dartmouth College is applying ERTS data to land use mapping in the northern third of the eastern seaboard megalopolis from Connecticut to Maine. The results he obtained from an initial "quick-look" analysis of a single image show that it is possible to completely classify a region into one of eight selected categories. An M.S.S. color image of lower New England (upper left), with Boston at its upper right, was used by Simpson to construct the 1:250,000 land use map of Rhode Island shown at lower left. An area of 1,200 sq. mi. was done manually by Professor Simpson and his assistant in 40 man-hours, a rate of 30 sq. mi. per hour. Professor Simpson was able to distinguish areas with multi-family/single family dwellings, urban centers of populations greater than 7,000, ponds of 300 ft. diameter, commercial areas of 800 ft. on a side, roads, highways, etc. Prior to the launch of ERTS-1, probably few, if any, would have believed either the speed or detail with which Professor Simpson has performed this initial land use classification—from a single ERTS image and without sophisticated tools.

Monitoring Coastal Water Quality: (opposite) An interesting application of ERTS data to water pollution monitoring has been demonstrated by Dr. C. T. Wezernak of the University of Michigan. The image of the New York City area at upper right was taken on August 16, 1972. Dr. Wezernak has pointed out that the tonal variations in the water of the New York Bight (the Atlantic Ocean) are due to the presence of suspended soil material and thus are indicative of water quality.

A looping pattern in the scene is more clearly shown by a band 2 image of the area, which has been enlarged and printed as a positive at lower right Using simultaneous aircraft overflights, it was verified to be the remains of an iron acid dump made from a barge which traversed a hairpin pattern about 10 hours prior to the ERTS overflight.

The principal contaminants are known to be sulphuric acid (about 8 per cent) and ferrous sulphate (about 10 per cent, which form a fine suspension whose spectral reflectivity peaks between .6 and .7 m (in M.S.S. band 2). This ERTS photograph shows that the material does not tend to dissipate very quickly. The innermost end of the hairpin has been distorted by the southerly flow of water along the New Jersey shore.

The acid dump was made at a point substantially closer to Long Island and the New Jersey shoreline than is specified for acid waste disposal sites. Acid is evident in all ERTS images taken of the area to date. Repetitive observation indicates that drift is south-westerly, resulting in impact on the New Jersey beaches.



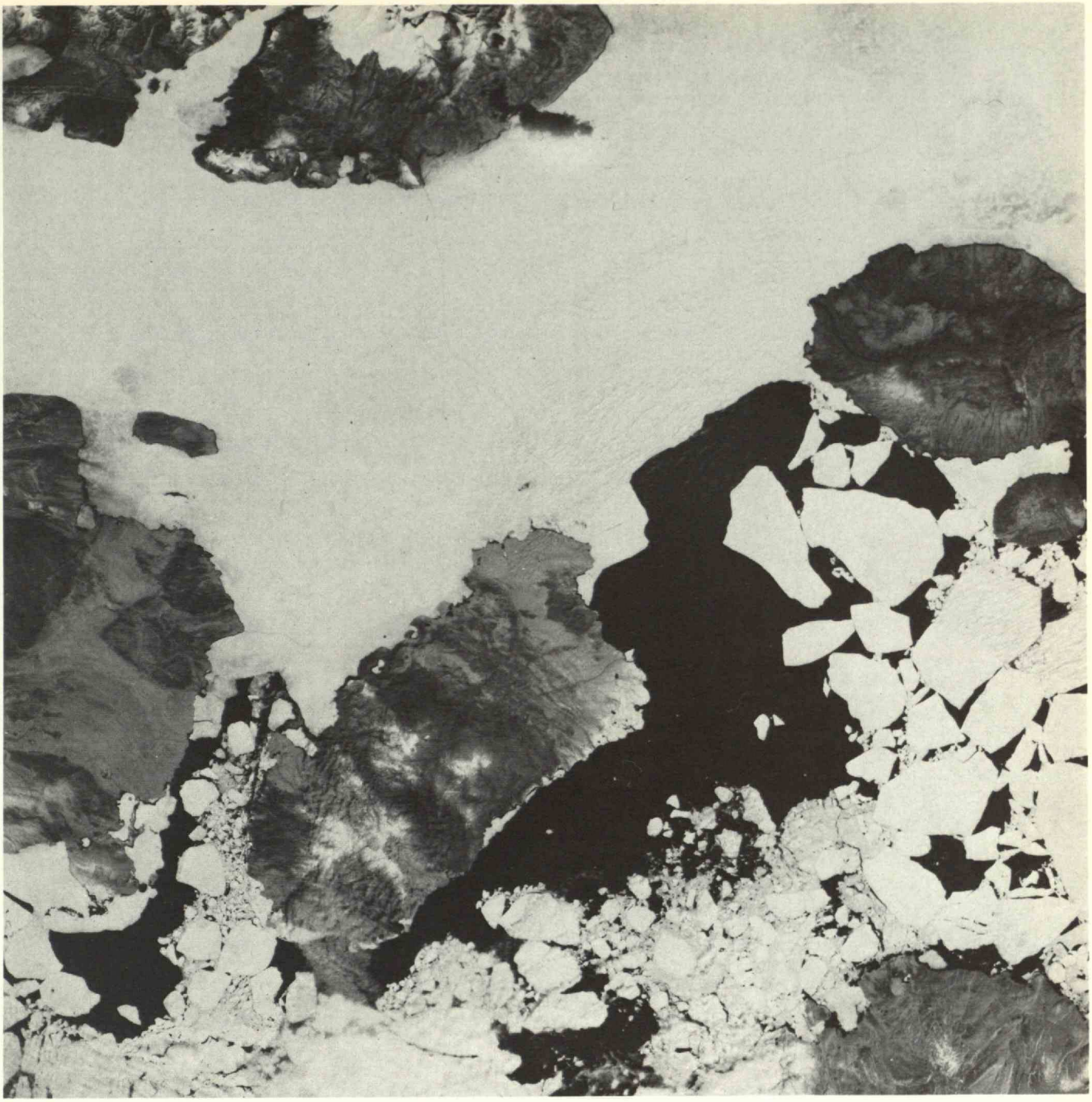
The area to the north and east of the acid dump, which also exhibits tonal variations, is used for depositing about 12,000 cubic yards of sewage sludge each day. The last known sludge dump deposited about 2,500 cubic yards about one hour before the ERTS overflight. The visibility of the sludge in the various bands gives an indication of its concentration and depth below the surface. Note also the effluence as the Hudson River enters the harbor area and its waters disperse in the Atlantic.

Initial analyses of imagery from several successive ERTS-1 orbits have shown the extent, predominant drift, and dispersion characteristics of waste disposal in coastal New Jersey waters. Imagery in M.S.S. bands 4 and 5 for several orbits shows the New York Harbor tidal discharge extending as far south as Long Branch, N.J. ERTS-1 imagery is being used by the New Jersey Department of Environmental Protection (N.J.D.E.P.) to develop information that will assist the state in optimally managing its coastal resources and in allocating funding. In other investigations, it was determined that within the bays, sounds, and thoroughfares behind the barrier islands in the southern New Jersey shore area, the increased reflectance of the turbid waters illustrates the effect of a large sewage effluent flow. As these waters are flushed with each tidal change, the turbid waters reach the populous bathing beaches of this area.

Monitoring Water Pollution: (left) Dr. A. O. Lind of the University of Vermont has been studying water pollution, lake turbidity patterns, and land use in the Vermont area. In his report on these studies at an ERTS-1 Symposium held March 5 to 9, 1973, he described the first use of space imagery in the prosecution of a violation of environmental laws.

The enlargement of an ERTS image (at left) shows a part of the Lake Champlain region. The International Paper Company mill is located on the New York side of the lake, north of Ft. Ticonderoga (white spot in image). Since March, 1971, this plant has been discharging treated wastes into the lake at the rate of 21 million gallons per day. The waste plume is visible as the darker area in the otherwise light tone of the turbid southern portion of the lake. It is 500 or 600 meters long and extends to the east toward Vermont. It contains suspended solids and is high in sodium and phosphates. Its reddish-brown color is most readily detailed in the 0.5 to 0.6 micrometer band of M.S.S. imagery, which is shown here.

Based on this imagery, in conjunction with ground observation and measure-

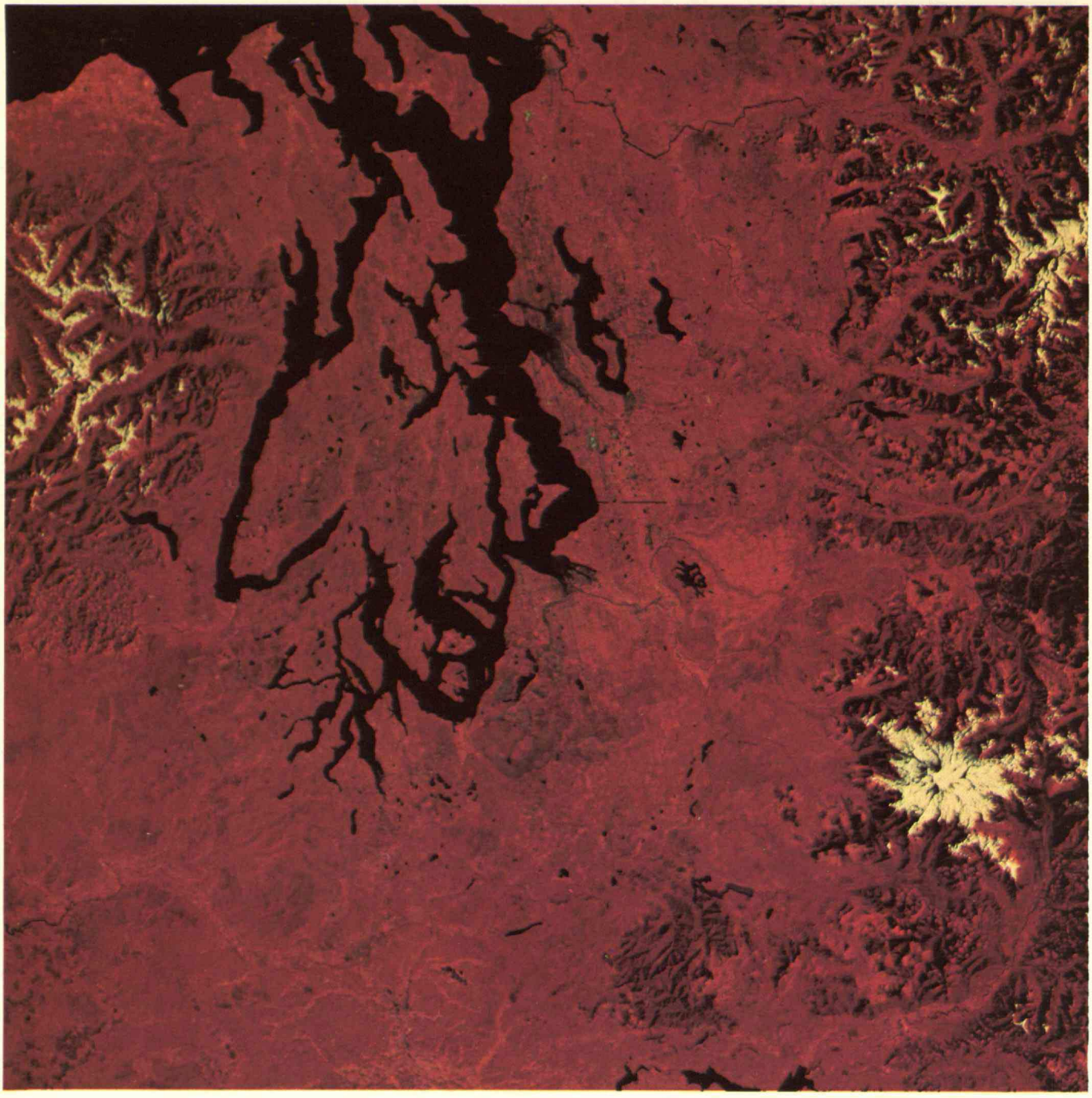


ments, the State of Vermont has taken legal action against the paper company and the State of New York, alleging that the new plant is reducing the water quality of the lake below Vermont standards and that these pollutants do, in fact, cross state lines.

Monitoring Sea Ice Conditions: (above) Accurate information concerning the conditions of sea ice and its movements is relatively difficult to obtain in the high latitudes of the earth. This information is necessary to reduce the hazards of shipping in areas such as the Bering Sea, Hudson Bay, and the Great Lakes (in particular, Lake Erie, due to its shallow depth) during the winter months. Recent discoveries of natural resources, such as oil, in the Arctic regions have increased the need for monitoring ice conditions. A cooperative effort between the United States and the Soviet Union has been undertaken to study ice conditions in the Bering Sea as they pertain to ship navigation. Sea ice conditions are also useful in the area of climatology since the movement and extent of ice packs reflect local as well as world climates.

ERTS-1 investigators, including Dr. Paul McClain of the National Oceanic and Atmospheric Administration (N.O.A.A.) and James C. Barnes of Environmental Research and Technology Corporation, are evaluating the application of ERTS data to detection and mapping of sea ice. The near polar orbit of the ERTS-1 spacecraft produces increased image overlap at higher latitudes and hence provides views of these portions of the earth more frequently than every 18 days.

Initial work by Dr. McClain was done using images of the same area in the Queen Elizabeth Islands taken four days apart on August 23 and August 27, 1972. Immediately above, we show an area from the Band 1 M.S.S. image taken on the 23rd, in which a considerable amount of broken ice is present in the channel between the islands, while the later image shows that clearing of this broken ice is nearly completed. The darkening of areas of sea ice, indicating the accumulation of surface



water from melting, is also quite evident in the film transparencies. Dr. McClain concluded that the ice type and movements were evident using ERTS data, as well as areas of melting ice, thus providing needed information concerning present and forecasted navigability of Arctic waterways.

Measuring Snow Line Elevation and Melting Rate: (above) In a mountainous region, the rivers and lakes are fed principally by water melted from ice and snow on the mountain peaks. A knowledge of the amount of snow and ice present in the mountain ranges and the rate at which it is melting is necessary in order to monitor and control the hydrology of the region. In many mountainous regions of the United States, numerical data on snow line altitude are obtained from aircraft overflights or ground observers for use by regional river forecast centers as input to computer programs modeling the area hydrology.

Donald R. Wiesnet of N.O.A.A. is investigating the application of ERTS data to snow boundry delineation and mapping. Wiesnet chose Mt. Rainier as a test site because of the availability of both ERTS data, and ground information for comparison. The ERTS M.S.S. color image of the Puget Sound area (above) was taken on July 29, 1972. It shows snow-covered Mount Rainier (altitude 14,408 ft.) at the lower right and the Olympic Mountains (maximum altitude 7,954 ft.) at the upper left. The show line is very evident in this image due to the high contrast between the snow and bare earth.

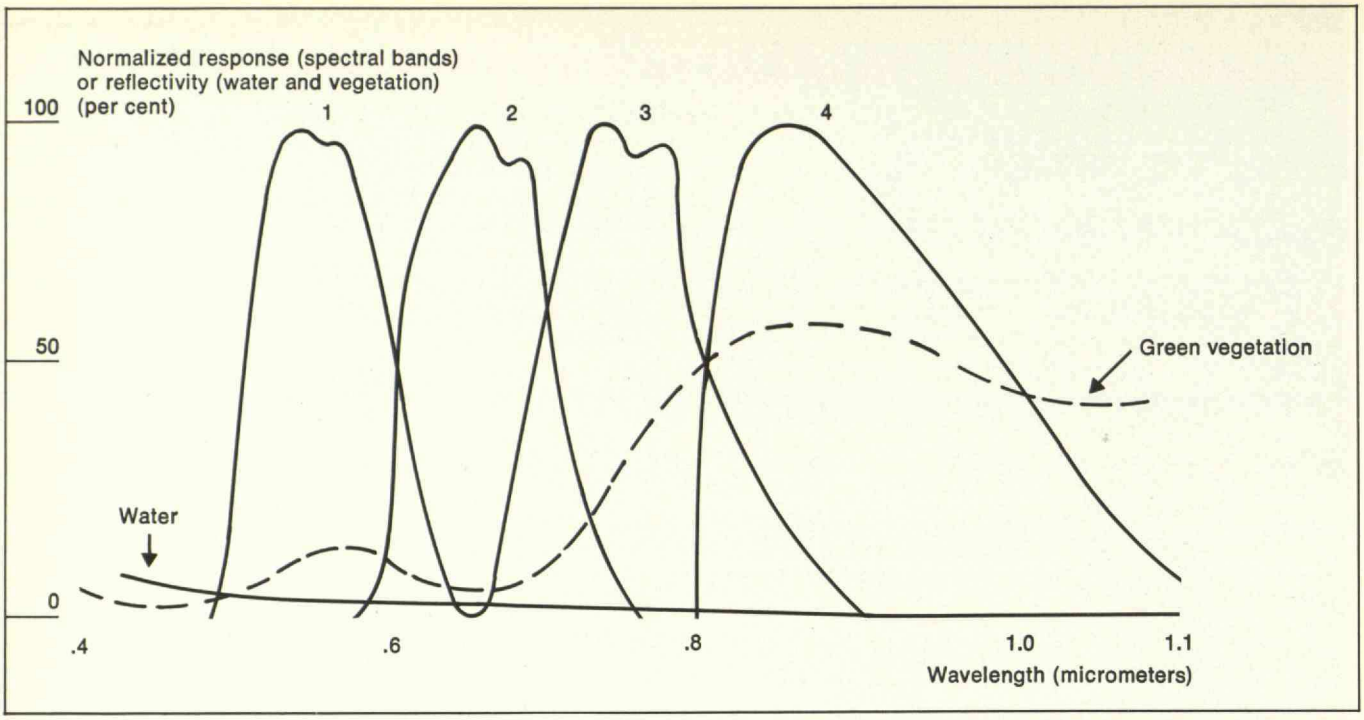
Dr. Wiesnet's initial measurements of the ERTS data estimated the snow line elevation at 5,500 ft. This compares well with the 6,000 ft. mean snow-line prediction of glacialists in Tacoma, Washington. Based on measurements such as these, Dr. Wiesnet concluded that ERTS data is adequate for all but the most stringent snow-line determination cases. However, he's not at all happy with the frequency of coverage from ERTS-1 (once every 18 days). He felt that a coverage cycle of no less

than two times per week is required in an operational system, due to the dynamic nature of the hydrology.

Crop and Soil Classification: (above) Agriculture resources inventory and control has been helped in the past by aerial photography which facilitated the identification of soil type boundries and vegetation cover. The utility of imagery to effectively survey and identify the many characteristics of soil and crops depends on the resolution of the imagery. Under reasonable contrast conditions, ERTS-1 data delineates features as small as 70 to 100 meters. Thus, there is clearly a limit for very small features and remote sensing from aircraft will continue to play a major role.

Several investigators are, however, attempting to define the role of ERTS data in agricultural land use, soil classification, forest identification, etc. Initial results obtained by Dr. Robert Colwell from the University of California/ Berkeley have shown that much information is available from, for example, the ERTS image of the San Joaquin Valley, California shown above. Dr. Colwell found that different crops displayed different colors. Small grains—mostly barley—appeared as yellow, safflower as brown, burned stubble as black, fallow ground as blue-gray, and healthy crops—mostly sugar beets and alfalfa—as red. Dr. Colwell said that 83 per cent of the crop areas in this image where ground data was available were properly classified. Typical field sizes in this locale are about 160 acres, but plots as small as 20 acres were readily resolved and classified. Most of the classification errors which occurred were in fields of very small size. Even better results would be expected using data from successive 18 day observations. In fact, later results have indicated that accuracies greater than 90 per cent were achievable.

While doing this and other work, Dr. Colwell has been keeping track of the interpretation costs using both ERTS and aircraft data. He has reported a reduction in analysis and interpretation costs of up to 20 times and more using ERTS data instead of aircraft data.



Each of the four filters in the Multispectral Scanner System on the ERTS-1 satellite has a different sensitivity to light (the curves numbered 1-4), and different features on the earth's surface (water and typical vegetation are shown here) reflect light in different ways. Thus the color composites constructed by superimposing the four differently filtered images show different characteristic colors for surface features.

(*Continued from page 33*)
throughout the mission life. Although largely based on previous design, the power, telemetry, command, and thermal subsystems of the spacecraft required some modification to meet specific ERTS requirements. The resulting observatory—all 2100 pounds—has performed almost flawlessly following its launch, its record unblemished except for the loss of one of the two wideband tape recorders.

The ERTS Ground Data Handling System is located at the Goddard Space Flight Center. This facility occupies nearly 40,000 square feet and contains high-volume photographic processors, large-scale digital computers, and special-purpose image-processing equipment.

The facility is separated into the Operations Control Center, used for scheduling and commanding the spacecraft, and the Data Processing Facility.

Conversion of the data, recorded from the satellite telemetry in a form somewhat like videotape, is accomplished using an electron-beam-on-film recorder which produces black and white images on 70 mm film of each spectral image from either sensor. During this conversion process, both radiometric and geometric corrections are made on the images. In addition, identifying information—some of this computer-generated before the arrival of the images—including latitude and longitude marks and a gray scale are written with each image.

Selected data (about five per cent of all the data processed) may undergo further processing. One such process is the application of scene corrections. Here, the specific geometric errors associated with the particular image being processed are measured. In addition, pre-selected points within the image, called ground control points, are measured and compared with the correct latitude and longitude of these points. The initial image is then rescanned and, applying the corrections and location data just determined, can be formatted in either the Universal Transverse Mercator Grid or the Polar Stereographic Grid System.

Creating Color

Multispectral remote sensing derives its utility from the fact that different materials have different reflectivities in various portions of the electromagnetic spectrum. Although this technology is not new and, in fact, has been previously demonstrated from both spacecraft and aircraft, ERTS-1 is its first application on so large a scale.

The illustration above shows the response curves for the four bands of the M.S.S. Each band is the result of a filter that passes certain wavelengths of light; each is centered at a different wavelength. This is not very different from human vision, where three light sensitive chemicals have three different response curves, from which color vision is constructed.

Superimposed on the response curves are the reflectivity curves for water and "green vegetation."

From the spectral characteristics of water, we can see that it has a very low and slightly decreasing reflectance with increasing wavelength. Each of the four spectral bands of the M.S.S. produces a black and white image; water would be quite dark in all of them. Measurements show it to become progressively darker as we move from Band 1 to Band 4. Vegetation, on the other hand, has an increasing reflectivity with wavelength, with a sharp rise in the near-infrared region of the spectrum. Correspondingly, we can see that vegetation in general will increase in brighness in the black and white images as we move from Band 1 to Band 4. Thus two broad classes of materials, water and healthy green vegetation, show marked differences in their responses in the various

spectral bands. The meaningful analysis made possible by ERTS-1 is the much more subtle differentiation between and within material classes in the face of intervening atmospheric effects.

In order to combine the information contained in the individual black and white images sensed in the separate spectral regions, false color representation is useful. Black and white transparencies from three of the spectral bands of a given scene are exposed on color film using a different color filter for each spectral band. When producing an R.B.V. color image, blue, green, and red filters are normally used in spectral bands 1, 2, and 3. For the M.S.S., these filters are used in either bands 1, 2, and 3 or 1, 2, and 4, respectively. The color produced in a positive film or print will depend on the superposition of the relative intensities of the different colors, created by the gray levels of the various spectral bands. For example, if the black and white transparency is very dense or black in all three bands, the color in the color positive will be printed as black. If the density in the first band is very light, in the second band very dark, and in the third band very light, a magenta color will be reproduced in the color positive, and so on. In this manner, a composite of much of the information contained in the separate black and white transparencies can be reproduced in the single color positive image.

Cities and developed urban areas typically show as a blue-gray in color renditions. In these areas a spattering of pink or red, depending on the amount of vegetation, such as grass or shrubs in the urban area, will usually be seen. Deep, clear water is generally a dark blue or black. Shallow water, particularly where bottom reflectivity is high or the water is muddy, appears as a lighter blue. Healthy, vigorous vegetation typically shows as a deep red. Fields of mature grains are depicted in a whitish tan color. Many shades ranging from pink to orange-red to deeper red tones record various agricultural crops.

Controlling the Orbit

A philosophy representing a reasonable compromise between capabilities and constraints, and reflecting some practical economies, results in the operation of the system at an average collection rate of just under 200 scenes per day. A typical day's operation includes 14 north-to-south passes of the spacecraft over the sunlit part of the earth.

The orbital altitude is adjusted so the 185-km.-wide swath of the earth viewed by the sensors on one orbit will lie just to the east of that viewed 14 orbits later (the next day), but with some (about 15 per cent) overlap so that no area is missed. After 251 orbits (18 days) the progression of swaths viewed around the earth's perimeter results in coverage of all areas. In fact, on the 252nd orbit, the satellite observes the same swath as viewed on the first orbit 18 days before. Thus each 18 days there is an opportunity to image the same areas of the globe. By carefully controlling the moment that the cameras are shuttered (in the case of the R.B.V.), the location of the images in the along-track direction is consistent from one 18-day period to the next. Thus a data user may be assured that all images collected over his particular area of geographic interest each 18 days will contain the same "real estate."

The ranges of the orbital parameters required for systematic coverage and reasonably constant illumination conditions are sufficiently narrow that the launch vehicle insertion errors must be trimmed by spacecraft propulsion. Further, lunar and solar perturbations and other spacecraft-generated orbital perturbations combine to cause the orbital parameters to drift outside their tolerance range. Thus, periodic adjustments to the orbit are required during the year-long operating mission.

The Promise of Future Systems

During the first six months of operation, ERTS-1 has imaged nearly 40,000 scenes of the earth's surface. From these, about 1½ million high-quality photographic images have been made and shipped from the data processing facility at Goddard Space Flight Center to investigators and several governmental agencies.

The applications we have discussed are based on very early results of only a few selected ERTS-1 principal investigators and are not intended to be complete or comprehensive. Among the additional application areas that are already indicating promising results are:

- ☐ Monitoring of strip mining activities and their effect on the environment.
- ☐ Monitoring of erosion and sediment patterns of coastal areas, to aid in designing protective structures.
- ☐ Locating potential mineral deposits.
- ☐ Exploration for the presence of ground water and locating potential fresh-water well sites.
- ☐ Detecting effects of insect infestation, insecticides, and disease on forests and vegetation.
- ☐ Definition of water currents and circulation characteristics, and finding likely fish-school locations by association with water quality and turbidity patterns.
- ☐ Identifying by previously unobserved geological features new areas of earthquake susceptibility.

These applications, together with those previously discussed, help to give an understanding concerning the future direction of ERTS data utilization.

For example, one expected benefit of ERTS in the area of agricultural resource management and control is the ability to detect not only vegetation type, as previously discussed, but also its state of maturity, and health. One demonstration of this capability was cited by D. E. Landgrebe of Purdue Laboratory. In 1971, some forest areas in the Ouachita Mountain region of Oklahoma were inadvertently sprayed with the vegetation-killing chemical 2,4,5-T in amounts not adequate to completely kill the trees. The foliage restored itself and in the summer of 1972 appeared normal to the human eye, but the ERTS data reflected its stressed state by recording a noticeably lower spectral response in the near infrared M.S.S. band.

For all its successes, ERTS-1 is still a research and development program designed to identify the most productive avenues to pursue in operational systems. The promise of these future systems, however, looks far more realistic from the vantage point of several months experience with ERTS-1.

100 Years of Women at M.I.T.

I came to the Inst in Jan 1871 in the fall of that year a very amusing incident in the history of co education occurred - I was at that time shut up in the Professors private Laboratory very much as a dangerous animal might have been Whenever the classes came into the 1st year Laboratory the door was kept carefully shut and I was expected to stay in I was not then allowed to attend any classes. After the term was well underway a young man came to the School who wished to take Mineralogy It was proposed to me as a good chance to take the extra lessons with him - So we two were sent into the corner room which was then the mineralogical room. The Professor of Mineralogy had many irons in the fire then as he has had ever since and after giving us some work to do he left us for a minute or two to see to something else. You all know how long his minutes are apt to be. When machines are in question - the result was that we two were left alone most of the time from 9 till 1 three days in the week. I think it was the most perfect bit of co education which I have ever met with It seems to have been eminently successful however for both of us have obtained by the Inst ever since and if we have gained any special reputation it has been chiefly in the line of work (rocks & minerals) which we began together then and in which we had worked ever since

June, 1973, marks the centennial of the graduation from M.I.T. of Ellen H. Swallow, who in 1871—the year of her graduation from Vassar—persuaded the faculty that she should be admitted as a special student in chemistry.

If M.I.T. heartily embraces women today, it hardly did in 1871; in the letter, Miss Swallow records how, to study mineralogy, she was "shut up in the Professor's private laboratory very much as a dangerous animal might have been. . . . After the term was well underway a young man came to the school who wished to take mineralogy. It was proposed to me as a good chance to take the extra lessons with him, so we were sent into the corner room. . . . The Professor of Mineralogy had many irons in the fire then . . . and after giving us some work to do he left us for a minute or two to see to something else. You all know how long his minutes are apt to be. . . . The result was that we two were left alone most of the time from 9 till 1 three days in the week. I think it was the most perfect bit of coeducation which I have ever met with."

Ellen H. Swallow, who graduated from M.I.T. just 100 years ago, devoted much of her life to excellence in science—and to achieving wider public understanding of women's potential for careers in science and engineering. Technology Review celebrates her achievements of a century ago with a series of two articles which reveal at once how much and how little women's world has changed in the 100 years since Miss Swallow became M.I.T.'s first alumna. Roberta Nichols shows that discrimination against women in science and engineering continues both in position and pay; and a group of women who have achieved careers in science and engineering recommend how today's continuing injustices can be corrected during the current decade.

Roberta Nichols
Chemical Kinetics Department
The Aerospace Corp.

Women in Science and Engineering: Are Jobs Really Sexless?

While there has been a steady increase during the last several decades in the number of college degrees awarded to women, the number of women seeking education and careers in the sciences and engineering remains pitifully small.

Certain indicators make one hopeful that this is changing. For example, the Chicago Student Science Fair had 40 per cent female entrants in 1972 as compared to 27 per cent in 1968 and 5 per cent in 1960. The enrollment of women in science and engineering curricula is gaining rapidly; the number of women registered at the Massachusetts Institute of Technology, for example, has grown from 401 in 1966-67 to 698 in 1971-72.

But there remains a long way to go before equality is achieved. Even as recently as 1969, only 2.5 per cent of the doctorates in physics were awarded to women.

A recent study by the Women's Bureau shows that the more education a woman has, the more likely it is that she will be in the labor force. In 1968, 34 per cent of women with only an elementary education were employed; of those who were high school graduates, 56 per cent were employed; of those with four years of college, 63 per cent; and of those with five years or more of college, 86 per cent. This last figure is approximately the work rate for men.

The work life expectancy for women has also increased—from 36 per cent of that for men in 1950 to 60 per cent in 1970. Twenty-five per cent of white married women with children are working, while 44 per cent of the nonmarried white women with children are employed. For black women, the figures are 41 and 52 per cent, respectively.

The proportion of women in less skilled jobs is increasing. In 1939 women comprised 59 per cent of all service workers (excluding private household), while their number was only 40 per cent in 1940. Despite great steps forward in removing sex discrimination, it is appalling that women are more disadvantaged in technical work, compared with men, than they were 30 years ago. In 1940, women held 45 per cent of all professional and technical jobs, whereas in 1969 the figure had dropped to 37 per cent.

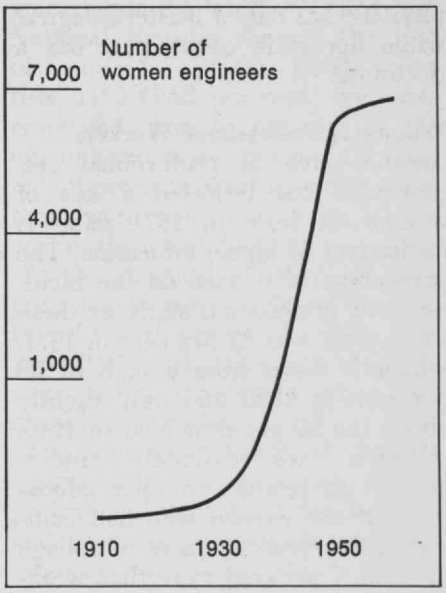
Few Students, Fewer Graduates

Why this trend in the wrong direction, giving women a decreasing role in America's rapidly growing technology?

Aptitude tests consistently show that two-thirds as many girls as boys have the aptitudes necessary for careers in engineering. No single reason will explain such a sharp difference in engineering aptitudes. The lack of early exposure and childhood training—the assumptions of parents and friends about the interests of girls, in contrast to those of boys—is surely an influencing factor. Another may be the apparent innate ability of males to conceive spatial figures more easily than females; but this may also be a cultural rather than a genetic factor.

The Society of Women Engineers advances other, very different, reasons for women rejecting engineering as a career: they do not think of it because there are few role models; they do not understand what engineering involves; or they feel they must choose between such a career and marriage.

But women do reject engineering: There were 3,245 female undergraduates and 1,186 female graduate students in engineering in the U.S. in 1969, but the proportion of graduates was even smaller: In 1969-70,



The greatest single factor in changing the employment of women as engineers was World War II, but the gains were short-lived: though the total number of U.S. engineers has increased continuously throughout this century, the percentage of women who were engineers actually decreased between 1950 (1.2 per cent) and 1960 (0.8 per cent). Since then the women have simply held their own at approximately 0.8 per cent among more than one million people employed as engineers. (Data: U.S. Census)

Trained in physics (B.S. University of California—Los Angeles) and engineering (doctoral candidate in environmental engineering, University of Southern California), **Roberta Nichols** is now engaged in research on air pollution control in internal combustion engines. She joined Aerospace Corp. as a mathematician in 1960, having earlier done analytical work for its predecessor Space Technology Laboratories and for Douglas Aircraft Co. Ms. Nichols' paper is adapted from her presentation to the Technology and Society Division of the American Society of Mechanical Engineers in November, 1972.

358 bachelor's, 170 master's and 16 doctorate degrees were awarded to women in engineering, while the respective numbers in 1970-71 were 353, 158, and 25. These figures represent in each case less than 1 per cent of the total engineering degrees awarded.

A 1971-72 survey of the Society of Women Engineers shows 7 per cent of women engineers with less than a bachelor's degree, 55 per cent with a bachelor's degree, 30 per cent with a master's degree, and 8 per cent with a doctorate. The most popular fields of engineering for women are electrical, mechanical, chemical, and civil, in that order.

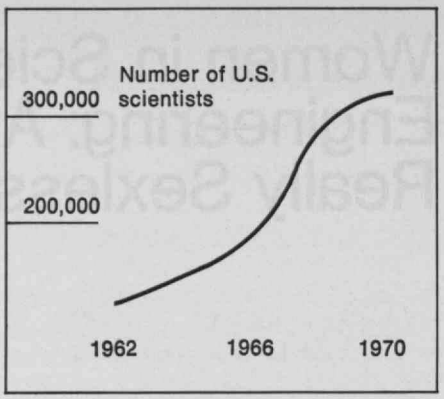
Similar data for graduate students in physics show that in 1967-68 only 3.7 per cent (562 out of 15,300) were women. However, only 2.2 per cent of the graduate degrees awarded went to women. Two years later, in 1969, women received 5.3 per cent of the master's degrees and 2.5 per cent of the doctorates awarded in physics in the U.S. In 1968, there were 290 female physicists with doctorates, 519 whose highest degree was the master's, and 343 with bachelor's degrees (a total of 1,156 female physicists). It is interesting that the typical woman physicist has only a master's degree, while her male counterpart has a doctorate.

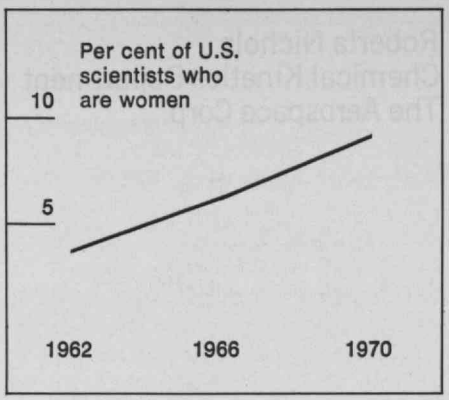
Women as Professional Workers

Another area of professional employment that reflected a loss of women—at least in 1971 data—is institutions of higher education. The percentage of women on the faculties and professional staffs of these institutions was 22 per cent in 1971, which is down from a high of 28 per cent in 1940 and only slightly above the 20 per cent held in 1910.

Women are definitely underutilized in relation to their education. Of the women who had completed five years or more of college by 1969, 7 per cent were then working as service workers, operatives, sales workers, or clerical workers; and nearly 20 per cent of women with four years of college education were employed in these occupations.

As professional and technical workers, women are most apt to be in teaching, nursing, and other health fields. In 1970, 4.3 million women had professional and technical jobs; 1.3 million women were non-farm managers, officials, and proprietors.





The total numbers of American scientists increased steadily during the past decade until 1968, when the growth rate declined sharply. Meanwhile, the women's share of the nation's science enterprise has accelerated slowly but consistently since 1962. (Data: Scientific Manpower Commission and National Science Foundation)

Women are far less likely than men to be found in these positions.

Although women are well represented in the health fields, only 7 per cent of all physicians in 1968 were women. Only 3 per cent of all lawyers and 1 per cent of all federal judges are females.

The summaries of American science manpower by the National Science Foundation (1964, 1966, and 1968) show that less than 10 per cent of all scientists are women (see the chart on this page). For women employed in the natural and mathematical sciences, the distribution is shown in the chart on the next page. As can be seen, chemistry is, by far, the most popular field.

The Pay Check: Monthly Discrimination

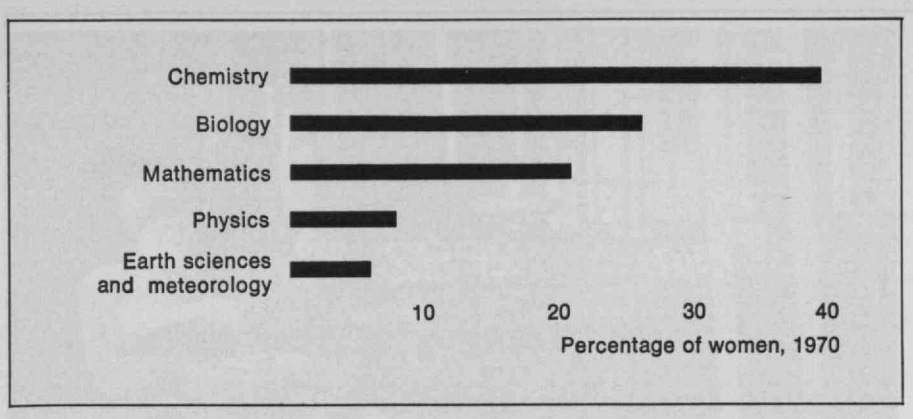
The best-known area of discrimination against the female sex is in respect to earnings. In 1957, the median wages paid to all women workers in the U.S. were 64 per cent of those paid to men. By 1968 the proportion had actually dropped to 58 per cent; the average earnings gap then amounted to more than $3,000 a year.

The situation is not much better for college graduates. The average monthly starting salaries in six fields of interest differed by $18 to $86 per month for the male and female college graduates in 1970, with women receiving less in every instance. What is even worse, this salary gap widened at the Ph.D. level and with years of experience. There is one notable exception: In 1971 the average starting salary being offered to women engineering graduates at the bachelor's level was $885 per month, while the starting salary being offered to men was $877.

According to the N.S.F. science manpower summaries, the median annual salary for men surveyed in 1964 was $11,000, compared with $8,400 for women. In 1968, the salary figures were $13,500 and $10,000 respectively. The median income of the 4.3 million women holding professional and technical jobs in all fields in 1970 was reported by the Department of Labor to be $7,309; this was only 65 per cent of the comparable figure for men.

Since the salaries in the field of chemistry are well documented, it is possible to examine some trends in detail (see the chart on page 47). Women with bachelor's degrees in chemistry earned 15 per cent less than men in 1970. Women working in those fields of chemistry which attract the higher percentage of women have consistently lower median salaries. Women employed in education are the lowest paid at all degree levels, and yet 26 per cent of female chemists are in teaching as compared to an overall average of 19 per cent. The largest percentage of women are in biochemistry, followed by analytical chemistry. However, the highest-paid field for women at the Ph.D. level is polymer chemistry; at the bachelor's and master's level it is physical chemistry.

Overall, the chemical industry has had about the same percentage of women employees since 1953, but increases in the percentage of women chemists have been reported. For



Women are better represented in most of the natural and physical sciences than in science as a whole. Chemistry is, by far, the most popular field; is it possible, the author has asked, that there is a correlation between the female's early training in cooking and her later chemistry experiments? (Data: Gloria B. Lubkin, *Physics Today*, April, 1971)

example, in 1962, the proportion in most of the fields of chemistry was 95 per cent men and 5 per cent women. There were two exceptions; biochemistry had 15 per cent women and "other" (administration, patent agents, technical writers, etc.) had 13 per cent women. In 1964 to 1966, 7.6 per cent of the chemists were women.

By 1970 the A.C.S. reported that 94 per cent of chemists were men. In 1971 the women, continuing to gain, were 7 per cent.

The highest-paid women in the American Chemical Society's survey were those in management, but only 5 per cent of the female chemists in 1970 were in management positions, as compared to 24 per cent of the male chemists.

Self-Discrimination in Advancement?

Even in engineering, where women seem to fare the best, there are still barriers to attaining positions of management. An Engineers Joint Council survey in 1970-71 indicated that nearly two-thirds of all salaried employees with technical degrees have some meaningful supervisory responsibility, and yet very few women manage to become supervisors.

Yet 41 per cent of all firms surveyed by the Women's Bureau of the U.S. Department of Labor said they hired women executives. None found their performance unsatisfactory, 50 per cent rated them adequate, 42 per cent felt they were equivalent to their male predecessors, and 8 per cent rated them better than their predecessors.

The American Physical Society study on women in physics showed that they are far less likely than men to advance into management jobs. This was true for all types of employers. The American Physical Society itself was an example: 0.4 per cent of its committee members in the past ten years have been women, 0.6 per cent of the invited papers were presented by women in 1969 and 1970, 0.4 per cent of the sessions were chaired by women, none of the divisional officers in the 1970 A.P.S. Directory were women, 0.3 per cent of the editors have been women and 0.2 per cent of the regional officers; only 0.8 per cent of the Fellows of the A.P.S. are women. Since females are 2.1 per cent of all Ph.D. physicists listed in the 1970 National Register, these figures are clearly out of proportion.

Women themselves may represent one of the persistent obstacles to their attainment of management positions. A woman may never aspire to such a goal because she automatically assumes it would be impossible to attain. Women must become more aggressive and take more active parts in their technical organizations and professional societies.

The female respondents in the American Physical Society study did not publish as much as their male colleagues. However, 42 per cent have participated in professional events. Studies of the relative productivity of men and women in the sciences, in general, suggest that married women, especially those with children, publish more than both the unmarried women and the married and unmarried men.

Women are not as prone to changing their jobs as men. When the American Physical Society's Committee asked why, the answers suggested that discrimination played a significant role: no better positions were available (24 per cent), discrimination (22 per cent), and family responsibilities (26 per cent).

The problem of limited mobility is cited repeatedly as a cause of limited advancement for the female professional. Nepotism rules, particularly at the universities, have discriminated against women and caused many hardships. And there are numerous other examples of difficulties which women have all had to cope with while pursuing careers that have been traditionally male occupations. Some are so simple as to be ridiculous. For example, how many companies have claimed to be unable to hire a female production engineer because they have no suitable sanitary facilities in their shop areas?

"Take a Year; Learn to Cook"

There is ample evidence that women were far more affected than men by the depression in science and engineering in the late 1960s. The 1970 National Register showed that out of a total of 125,000 Ph.D. scientists, 1160 (0.93 per cent) were unemployed. Twenty per cent of the unemployed were women, although only 9 per cent of all scientists registered were women and only 2.1 per cent of them had doctorates.

In the chemical industry, the proportion of women employed dropped from 21 to 20 per cent between 1969 and 1971, indicating that females were being terminated more frequently than males.

An American Chemical Society survey of its members—basically the professional workers in this industry and chemists in academic and government work—in March, 1972, showed a slight decrease in unemployment of men, 2.4 to 2.3 per cent, while the unemployment of women increased from 6.3 to 7.3 per cent. Here, again, is evidence of discrimination. Many male employers seem to take the attitude that a woman employee is not really a breadwinner because she has some man to take care of her. A typical remark was reported to the Committee on Women in Physics of the American Physical Society by a

Woman in the Shop

Writing for the Michigan Agricultural College Record *in 1896 (he was then teaching mechanical engineering at M.A.C.), Charles L. Weil (M.I.T. '88) found himself a bit ambivalent—but also ahead of his time: "Perhaps it is simply 'an old-fashioned note of propriety' that leads some to prefer seeing a woman at work sewing, cooking, or at household duties rather than engaged in cleaning castings," he wrote.*

When a young woman enters upon the study of one of the technical professions, involving in its study practice in shops, it is not only desirable, but necessary, that she carry on such shopwork as is undertaken by young men engaged in the same profession. In engineering and similar technical school shops, the intention is to present to the student the underlying principles and the main processes of a number of trades that touch directly upon the student's future professional work; the acquisition of a knowledge of a number of trades is the object sought, rather than manual dexterity in any one trade, and such knowledge constitutes professional capital.

We conclude then that it is both essential and fitting in primary manual training and in the study of certain technical professions for girls and young women to undertake certain lines of shop work that have been considered in the past by many to form particular fields for boys and young men.

Need we consider "Woman in the Shop" as the student of a special trade, and of such trades as men have been considered heretofore peculiarly adapted to undertake? It would seem that woman has entered upon this work also. At a recent meeting of the American Society of Mechanical Engineers Mr. Gobeille, the manager of large industrial works, made the following statement: "Seriously I believe the 'woman question' will be prominently before the society in a few years. In a little while women will be running all the lighter tools in machine shops and factories. This is certainly coming. I am doing it and others must come to it."

We are of the opinion that the above is a somewhat extreme view of future industrial condition; nevertheless the statement is one worthy of serious consideration because of its source.

"Uneasiness" About our Future "Industrial Condition"

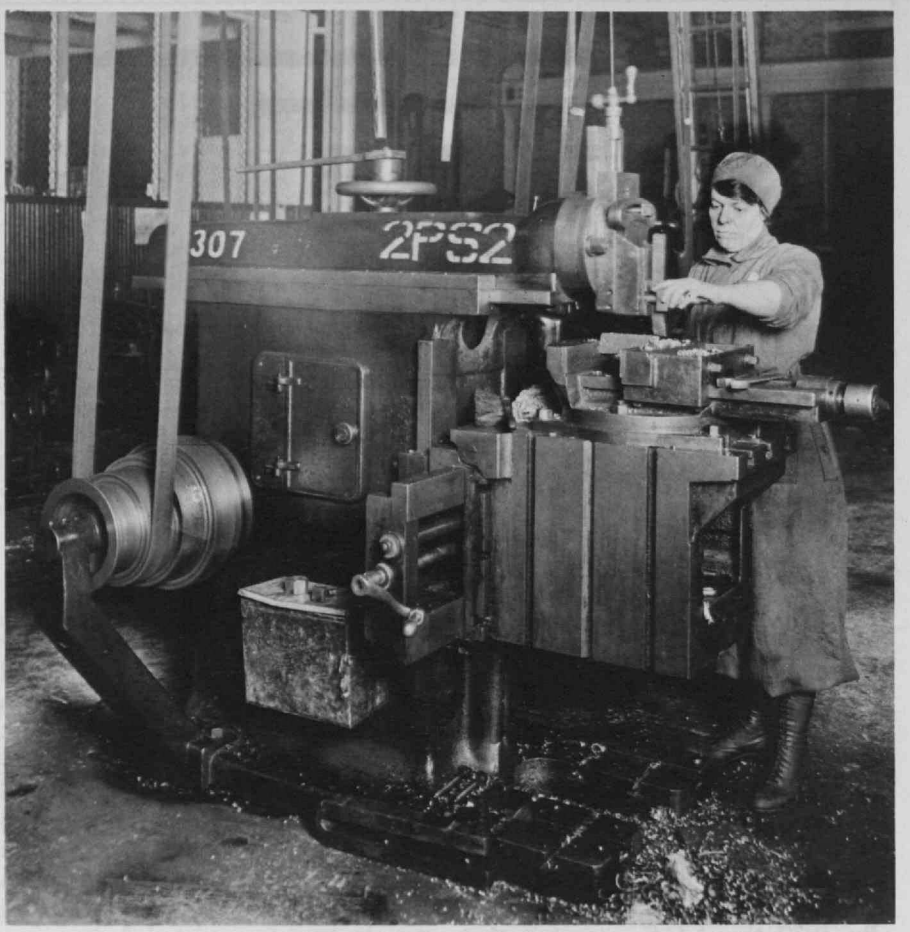
We know that at the present time women are employed in shops and foundries doing work that has been considered in the past suitable only for men; still we have not expected that women would enter the industrial walks of men to the extent predicted by Mr. Gobeille. But if Mr. Gobeille predicts correctly we cannot but apprehend with some uneasiness our future industrial condition.

However, we are inclined to believe that in case women in this country are going into the machine and similar shops, it is because of lack of opportunities to learn such trades as cooking, weaving, and housework—trades that many people consider more especially fitting for women. It would seem that a condition of affairs confronts us that points out the necessity of establishing numerous trade schools where young women may be taught those trades for which women are more particularly adapted.

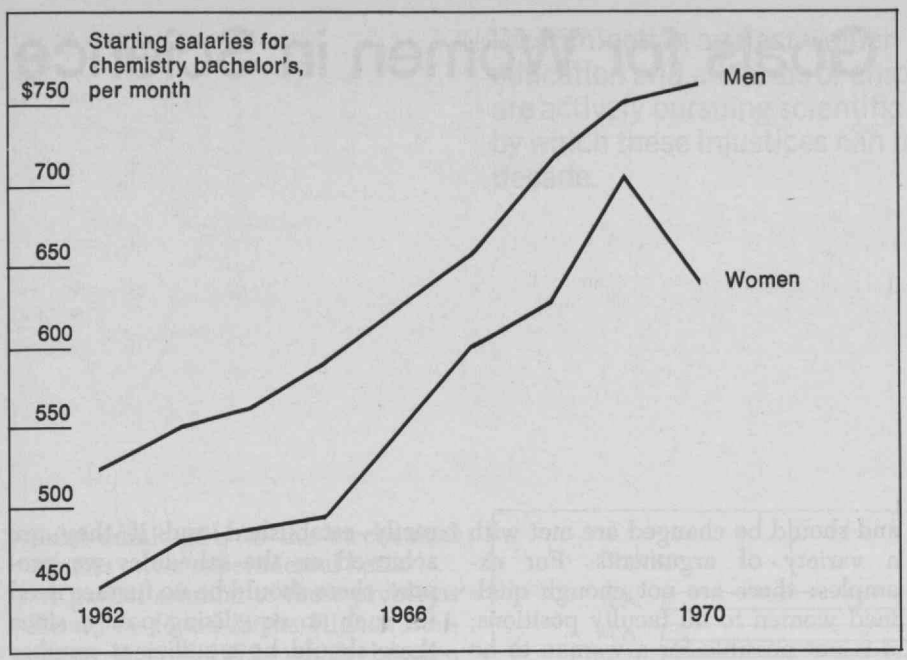
But some may say that we should not attempt to draw any line in regard to "adaptability," and that a woman has "as much right" to become a machinist or a blacksmith as a man or as some other woman to become an architect, and we do not question this right. Perhaps it is simply "an old-fashioned notion of propriety" that leads some to prefer seeing a woman at work sewing, cooking, or at household duties rather than engaged in cleaning castings.

Woman finds a place in the manual training school shop and in the professional school shop, and it is also true that in many of our factories, in certain lines of work, a place is made for woman; but we are inclined to believe that such an "wholesale" entry of women into machine shops, foundries, iron works, and so on, would not tend toward the elevation of mankind, and that it is not advisable to arrange for girls' trades schools along such lines.

The essay from which these comments are drawn was originally published in the M.A.C. Record *(of Michigan Agricultural College) for October 13, 1896, when Professor Charles L. Weil was engaged in developing that institution's Mechanical and Engineering Departments. It comes to the* Review's *attention through the interest of Mrs. Elizabeth Weil Wright of Battle Creek, Mich., the author's daughter.—Ed.*



What is the value to women of training in shop practice "as is usually considered to afford a particular field for men"? Professor Charles L. Weil (M.I.T. '88) answered in 1896: If women "are going into the machine . . . shops it is because of lack of opportunities to learn such trades as cooking, weaving, and housework"—hardly a satisfactory answer today, nor one which comprehended the demands of World War I. (Photo: Watertown Arsenal circa 1918, from the Schlesinger Library, Radcliffe College)



Data on starting salaries offered to chemistry graduates at the bachelor's level during the past decade confirms allegations of discrimination against women. Women's pay improved as a result of the several equal-pay laws enacted in the mid-1960s; but when jobs for chemists grew scarce in 1970, women were the first to lose. (Data: David Roethel in *Chemical and Engineering News*)

woman physicist with a Ph.D. who was looking for a job: "Why don't you take a year off . . . and . . . well . . . learn to cook? . . . After all, your husband has a good job."

The recent emphasis on equal opportunity laws has led, in some cases, to reverse discrimination, particularly in hiring practices. Some companies are hiring women in place of men in order to meet their "quotas." However, the fact remains that more subtle kinds of discrimination continue to exist after women become employees. Promotions in terms of both wages and position are often not as good as the equivalent man's advance. Management positions remain especially difficult for a woman to achieve.

A Woman Design a Dangerous Toy?

There is no evidence that women who choose scientific or engineering careers are inferior to their male counterparts in terms of qualifications or performance. Indeed, quite the contrary is usually true; the women presently in the sciences and engineering usually must have exceptional ability and great determination in order simply to be able to pursue traditionally male careers. As more and more women enter these ranks and these jobs really do become "sexless," then it will be reasonable to expect enough equality in both numbers and in employment policies to truly consider each individual on his or her own merits.

There are in fact reasons for suggesting that women may have special talents and interests to bring to technical work. The average woman may well operate more technology every day than the average man, and she should thus acquire some technical "know-how." Even more important, she should bring a sense of the practical to many technological developments—if for no other reason than because she has been a careful buyer of many consumer products. More women than men are making decisions when it comes to buying such products.

Thus I propose that women should have a very important role to play in consumer product engineering. Who knows better the importance of uniform boxes and proper labels? The female engineer would do away with planned obsolescence and hazardous toys.

Half Way to Saturation?

It must become a natural step for the female with technical talent to enter the professional world. Her education should not be filled with traumatic experiences because she is some kind of oddity. One of the major advances must come in the form of better high school counseling and teachers who will recognize and encourage the woman who has scientific aptitude. The image of apparent aversion to mathematics must be erased, because mathematics is a necessary tool in varying degrees in all of the sciences.

Many years of biased thinking have to be overcome. Attitudes defining the proper roles for women are firmly ingrained into our culture. A very poignant example of this kind of thinking was found in a recent statement by Carl York, then a staff member of the Office of Science and Technology, when he put forth his "saturation theory." He said: "We are very near the point in the education of our population where we have saturated the supply of those who can be trained to be scientists and engineers."

This theory was promptly refuted by Harold L. Davis, Editor of *Physics Today*, who wrote: "Rather than being dangerously close to the point of saturation, it would appear that we are only half way to that point. . . We have ignored and failed to develop half of the brain power in the country merely because the brains belong to females."

Femininity need not be equated with ignorance of technology, and woman's acceptance into traditionally male occupations must not be at the expense of her role as a woman in both a physical and social sense. It must be possible for her to enjoy being a woman and at the same time be successful in her career in science or engineering.

Women in Science and Engineering, Boston, Mass.*

Goals for Women in Science

From the beginning of science it has been accepted that the role of a scientist is a masculine one, and therefore—by definition—any woman who becomes a scientist is renouncing her femininity. Even in this present generation, with its upsurge of interest in women's rights, the number of scientists who are women is a small percentage of the total. Girls with a natural interest in science find that many social pressures are brought to bear against them. Their peers scorn their interest; their parents and teachers discourage them from continuing with a serious scientific education. If they persist with their education despite this discouragement they are likely to find that, once they are qualified, they will still have to fight the various subtle and unsubtle forms of discrimination against them as they try to gain recognition in their field.

Statements that this situation can and should be changed are met with a variety of arguments. For examples: there are not enough qualified women to fill faculty positions; it is not possible for a woman to be an active scientist and a wife and mother at the same time.

It is in an attempt to refute these arguments that we here suggest what we consider are attainable goals for women in science over the next decade. Wherever possible we have been specific in these goals, with suggestions as to how they may be attained and timetables for implementation. We have tried to make the goals realistic; clearly the present pool of women scientists is painfully small, and we cannot achieve equality in numbers at all levels overnight. (At this point we emphasize the meaning of "goal" as we understand it: we mean a target, perhaps a numerical one, which should be aimed for and which can itself change with time. We do not mean "quota," which we understand as a numerical limit which cannot be exceeded.)

The ultimate goal for women in science is not a numerical one but a philosophical one: any person should be allowed and encouraged to pursue an education and career in whatever field he or she chooses, based solely on ability, commitment, and performance, and without regard to race, age, sex, color, religion, politics, etc. However, if we simply state this principle and expect slow change to correct the present inequities, we must contemplate a delay of at least a generation before the goal is even remotely approached.

For this reason we believe in determining numerical goals and setting realistic timetables for their implementation. If our goals are correctly established and if they are achieved on the schedules we propose, there should be no further need for such an equalizing policy, since there should be a sufficient number of women in science so that they can work and compete on an equal basis with men.

Many will argue that the factors operating against a potential female scientist come into play from her very birth, and that no solution is complete that does not consider preschool and elementary school training. While this is certainly true, we have limited ourselves in this report to those stages of a person's education and career development where there is a differentiation between scientist and nonscientist and where it is possible to set goals. Thus we start with high school and progress through undergraduate and graduate education to professional involvement. Profound changes at these levels will, in time, make themselves felt in the attitudes towards the male-female dichotomy in early childhood and in elementary education.

High School Science Education

Women first experience dissuasion from pursuing scientific careers in junior high school. In the past some of our leading science-oriented high schools have excluded girls completely, and in vocational schools at this level, girls are discouraged or, in some cases, prohibited from taking science-oriented courses. Boys, for example, can take courses in shop and mechanical drawing from which girls are excluded; the girls are usually required to take sewing and cooking. In 1972 more than two-thirds of the junior high schools in Massachusetts had this policy, while half of the remaining one-

---

*This article is a condensation of a report of the same title prepared during 1972 by an informal study group consisting of **Elizabeth Baranger**, Senior Research Scientist, Department of Physics, M.I.T.; **Delyle Eastwood**, Chemist, Bendix Corp., Detroit, Mich.; **Vera Kistiakowsky**, Professor of Physics, M.I.T.; **Nancy Milburn**, Professor of Biology, Tufts University; **Vera Pless**, Research Associate, Department of Electrical Engineering, M.I.T.; **Mary C. Potter**, Associate Professor of Urban Studies and Psychology, M.I.T.; **Linda Rothschild**, Assistant Professor of Mathematics, Columbia University; **Joan Ruderman**, graduate student in biology, M.I.T.; and **Nancy Tooney**, Research Associate, Department of Biophysics, Harvard University and Children's Cancer Research Foundation. The report, first published in draft form in August, 1972, was edited by **Margaret E. Law**, Senior Research Associate, Department of Physics, Harvard University.

An extended version of the report has been prepared for publication in book form.

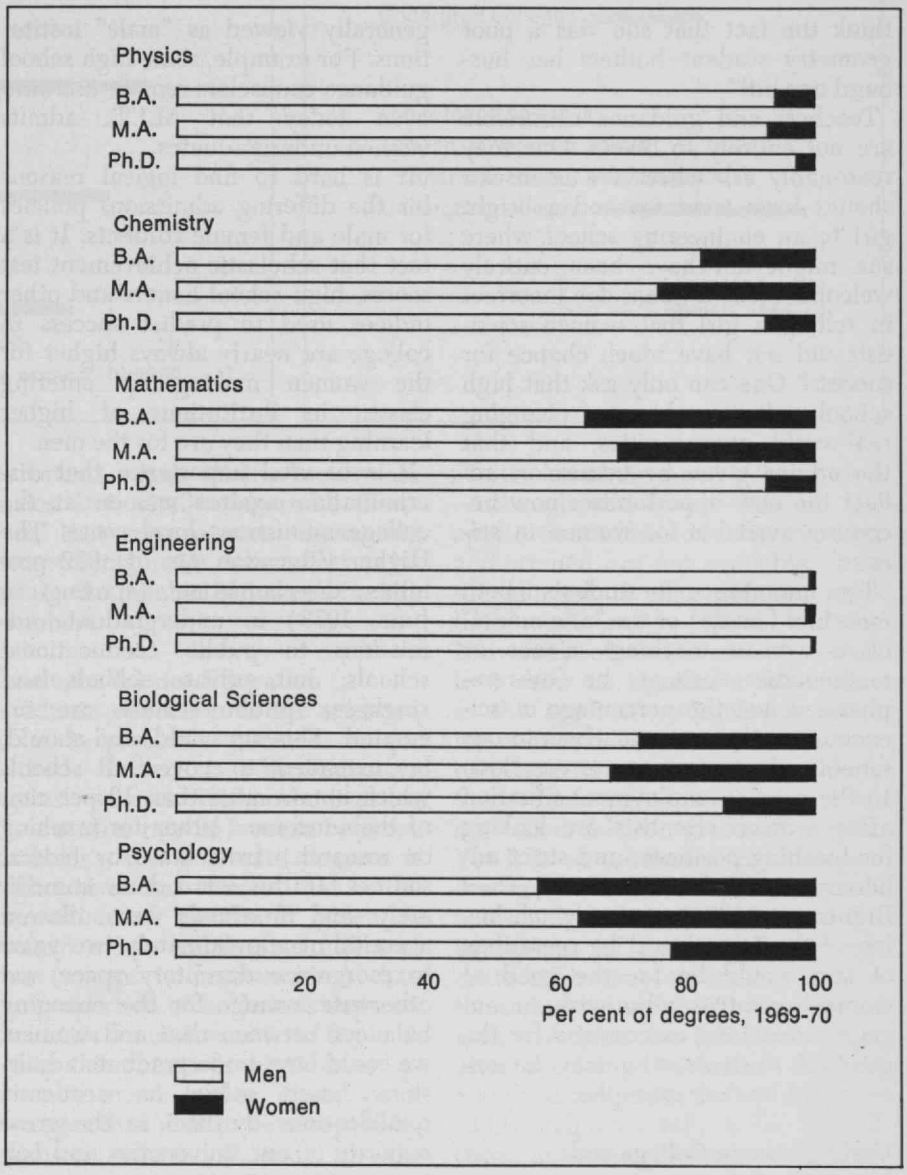
Discrimination against women in science appears in all levels of education and all forms of employment. Here ten women who are actively pursuing scientific careers recommend actions by which these injustices can be corrected during the current decade.

third admit girls to the mechanical courses on an experimental basis.

A partial solution to these problems should be found in the Higher Education Act of 1972, which became effective in June, 1972; it explicitly prohibits sex discrimination in all federally assisted education programs. But even strict enforcement of this act will not miraculously solve the problem. Girls must be actively encouraged to take science, mathematics, and industrial arts courses; indeed, we consider it reasonable in this technological age that all high school students, male and female, be required to take at least one course in general science which should contain a good grounding in basic physics, chemistry, and biology. Requiring such courses of all students would go far toward removing the label that marks "science" as a boys' subject; and such a requirement would at the same time help all students, whether continuing their education in science or not, to have at least some feeling for scientific discovery and facts.

A less tangible but very pervasive form of discrimination affects high school students: teachers and guidance counselors often do not encourage girl students toward careers in science or engineering and frequently even discourage such aspirations.

Stories about girls who do well in science being advised to become nurses are quite common. We examined a number of books on guidance and could find only one case history of a girl who became a scientist. The attitude of one book is best summarized in the "humorous" comment following the case history of a girl who became a teacher for two years and then quit to raise children: "Lesson: I don't



Women receive a small share of academic degrees awarded in the sciences in the U.S., and discrimination is most serious at the doctorate level. A committee of women scientists proposes in the accompanying article a series of reforms which they believe will within a decade bring more women into the sciences as undergraduates and bring the same proportion of women as men through to the highest academic degrees. (Data: Office of Education, Department of Health, Education and Welfare)

think the fact that she was a poor geometry student bothers her husband one bit!"

Teachers and guidance counselors are not entirely to blame. One may reasonably ask whether a counselor should have tried to send a bright girl to an engineering school where she might not have been entirely welcome. Was a counselor incorrect in telling a girl that women scientists did not have much chance for success? One can only ask that high school girls must learn of changing real-world opportunities, and that the advice given by counselors reflect the new opportunities now becoming available for women in science.

The importance to students (both male and female) of the "role model" of a woman teaching science or mathematics cannot be overemphasized, yet the percentage of science or mathematics teachers in our schools who are women is very low. In the present employment situation many women scientists are looking for teaching positions, and strict adherence to Title VII of the Civil Rights Act (1964), under which hiring of teachers should be regardless of sex, would be for the good of women scientists who wish to engage in teaching careers and for the good of students who may be encouraged by their examples.

Undergraduate College and University Science

The undergraduate educational resources of the nation—both private and state-supported colleges and universities—offer fewer places to women than they do to men. This is especially true of our more specialized institutions of science and engineering, which have either not been open to women or have been generally viewed as "male" institutions. For example, some high school guidance counselors remain unaware even today that M.I.T. admits women undergraduates.

It is hard to find logical reasons for the differing admissions policies for male and female students. It is a fact that scholastic achievement test scores, high school honors and other indices used to predict success in college are nearly always higher for the women making up entering classes in institutions of higher learning than they are for the men.

It is of vital importance that discrimination against women at the college admissions level cease. The Higher Education Act of 1972 prohibits discrimination (starting in June, 1973) in undergraduate admissions to public coeducational schools; but private schools and single-sex public schools are exempted. This act could, and should, be extended to cover all schools which obtain more than 10 per cent of their income (either for teaching or research) from state or federal sources. If this were done immediately, and if schools were allowed a period of approximately two years to reorganize dormitory space and otherwise arrange for the changing balances between men and women, we could have undergraduate admissions based solely on academic qualifications by 1975 in the great majority of our universities and colleges.

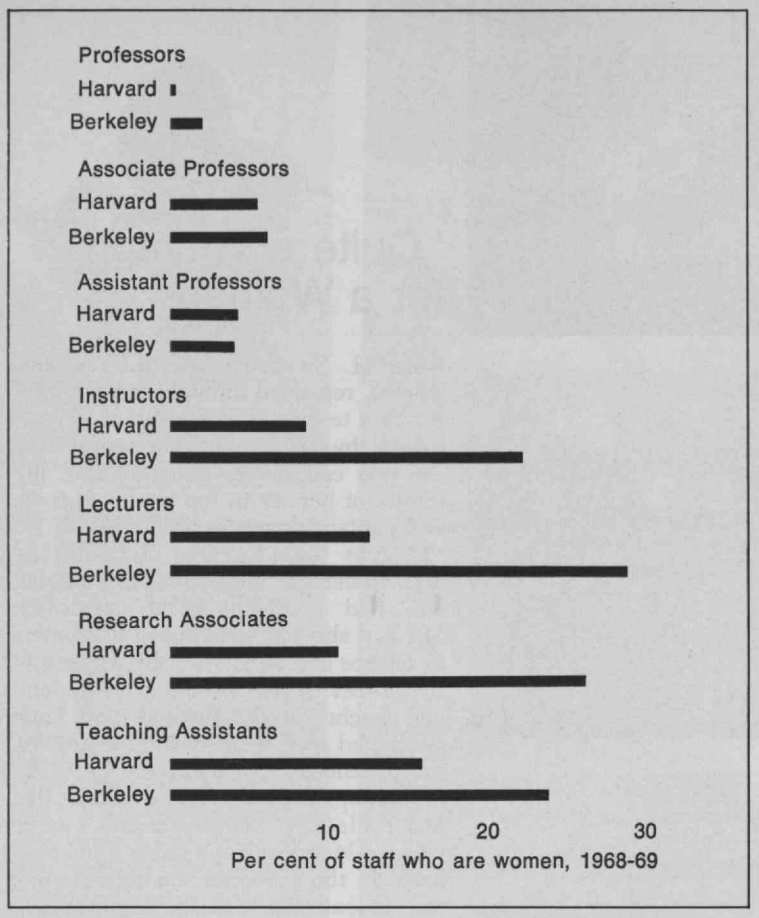
If the numbers of women admitted to undergraduate institutions increases, we may expect at least an equivalent increase in the absolute number of women science majors. But that alone will not resolve the problem. Women students who have ability and interest in science need to be encouraged by their advisers to take science courses and to major in science.

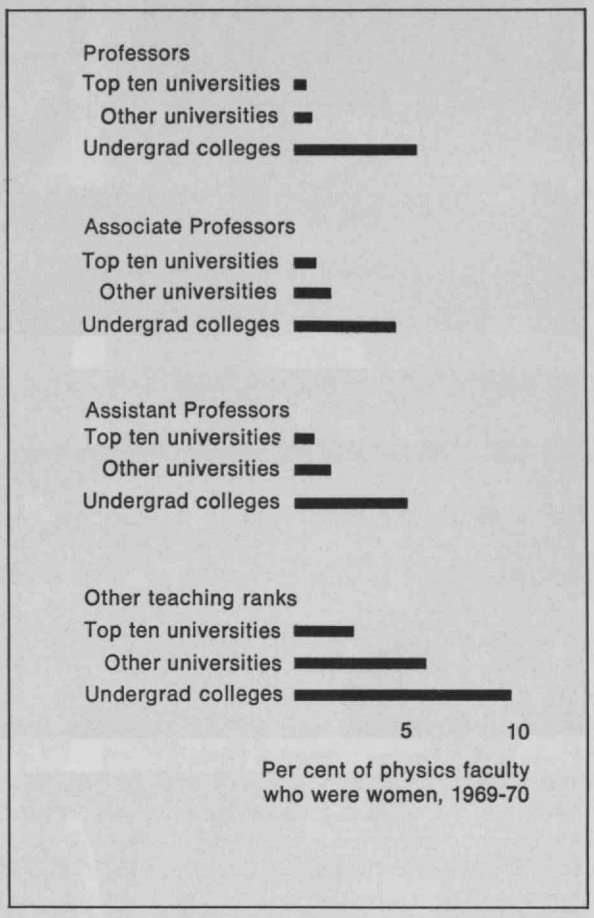
It is true that a significant fraction (in many institutions over 30 per cent) of the students who major in mathematics, the life sciences, and psychology are women. But the percentage for the physical sciences (physics, chemistry, and astronomy) is much lower (of the order of 10 per cent or less). At Duke, Cornell, Tufts, and Minnesota, for example, between 10 and 26 per cent of the women in the Classes of 1971 and 1975 chose to major in some field of science—compared to between 22 and 35 per cent of the men.

Why are women presently discouraged from taking such courses? Many women students are oriented towards courses in education, child study, languages, and English in order to acquire skills that are considered likely to be most useful. This reflects not only their interest but, we are told, also their high verbal skills and their ability to cope with detail. We suspect that such skills are often acquired after, not before, the fact!

Female students should be encouraged to think of their undergraduate training as leading to lifetime careers. But we must not ignore the complications that such a course presently entails, particularly in science. Frequently it means postponing marriage and children for many years. Often at the end of her education a woman finds that the employment opportunities available to her are far more restricted than those open to her male colleagues.

Some of these problems can be alleviated in obvious ways. The admission to undergraduate and graduate schools of older women who wish to resume their education after hav-





Women are significantly underrepresented on the teaching faculties and staff of all American universities; this is especially true in the higher ranks, in universities with little tradition of coeducation, and in top-ranking universities. (Data: left—University of California and Harvard committee reports; right—American Physical Society Committee on Women in Physics)

ing children should become a routine matter. In the same way it should become routine for students with other responsibilities to pursue education on a part-time basis. In both cases equitable amounts of scholarship aid should be available. Placement officers and advisers should make every effort to place able women students in positions which will lead to the full use of their potential as scientists.

Surely a significant factor in the low representation of women in the sciences and engineering is the present lack of female role models in those fields in the world at large and especially in our college faculties. Young women will be encouraged to contemplate careers in science when they see about them successful women scientists; they are unlikely to be comfortable—and may even feel like interlopers—in departments where all the faculty are males. It is vitally important, therefore, that science and engineering departments make every effort to increase the number of women faculty members.

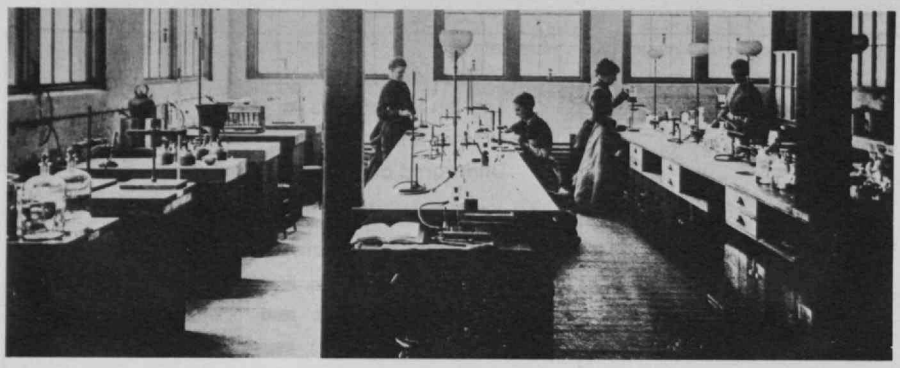
Graduate Science Education

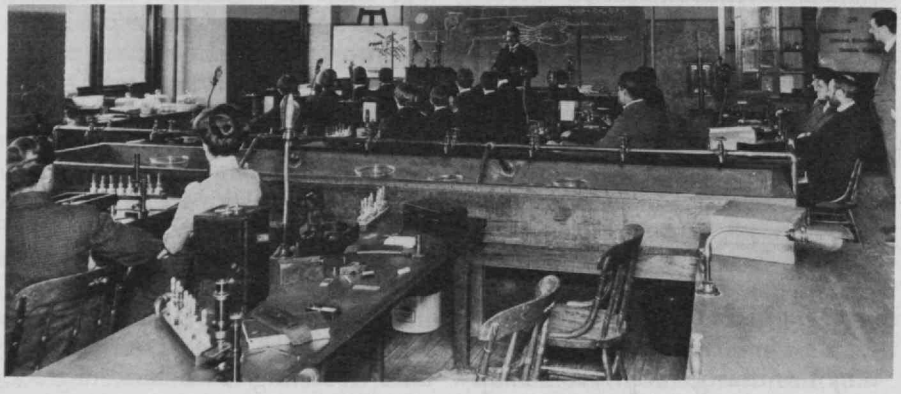
Graduate education in the sciences, as it is presently pursued in the United States, is discriminatory against women. Without exception, the attrition rate of women between bachelor's and doctorate degrees is higher than that of men; that is, the proportion of doctorates given to women is less by about a factor of two (except in mathematics) than the proportion of bachelor's degrees; the factor for mathematics is five.

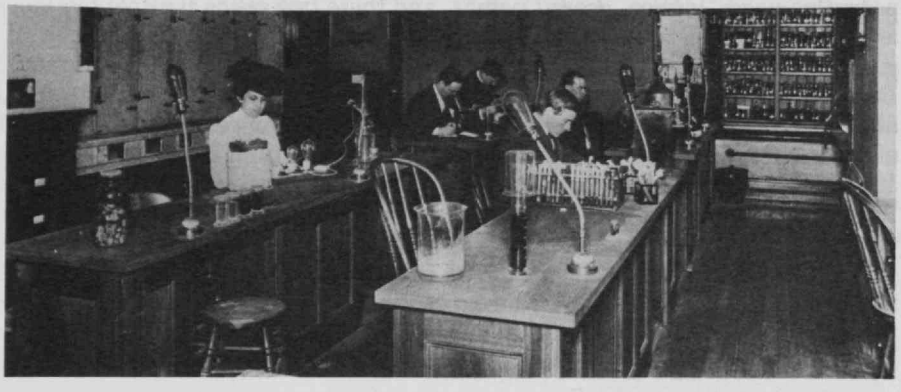
Why this drastic drop? Women apparently need higher grade point averages than men to be accepted by graduate schools. A study for the Department of Health, Education and Welfare showed that 67 per cent of the women doctoral students in 1965 had undergraduate averages of B or higher, compared to 54 per cent of the men; 37 per cent of women graduate students surveyed in 1969 in an American Council on Education study had undergraduate averages of A— or higher, compared to 25 per cent of the men.

Although nationwide data on the application/admission ratios for men and women are not available, from the admissions offices of two prestigious universities (M.I.T. and the University of California at Berkeley) show no significant differences in the application/admission ratios for men and women in most scientific departments. It does seem, then, that women are applying to, and being admitted to, graduate school. Yet it is not sufficient that the percentage of women applicants admitted to graduate school equal the percentage of men applicants admitted. The important issue is that the same proportion of women as of men continue to advanced work after receiving bachelor's degrees, and these two ratios are not equal.

This inequality reflects the lack of encouragement given to undergraduate women in the sciences, which in turn directly reflects the attitudes of faculty and administrators about the role of women in our society and faculty expectations concerning the performance and future of women as graduate students and as scientists. There is no evidence that the scholastic ability of bachelor's degree women is any less than that







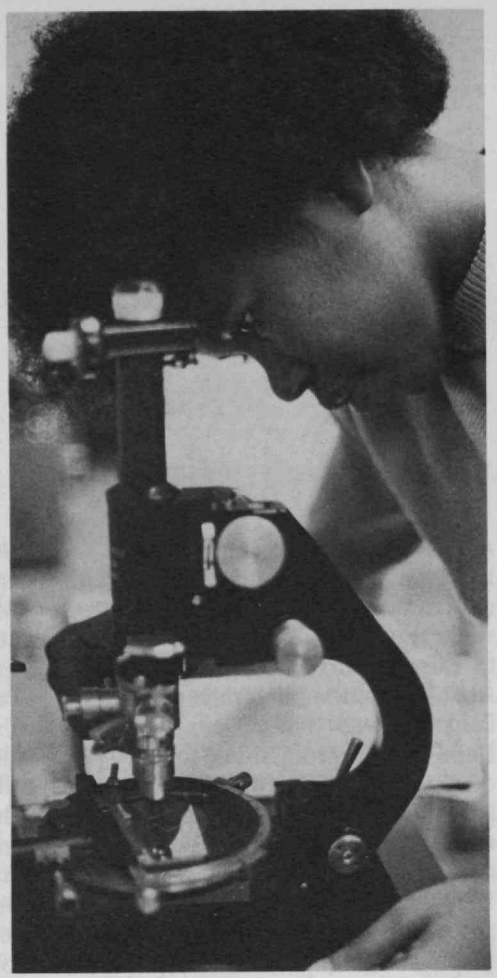
"Quite a Triumph for a Woman"

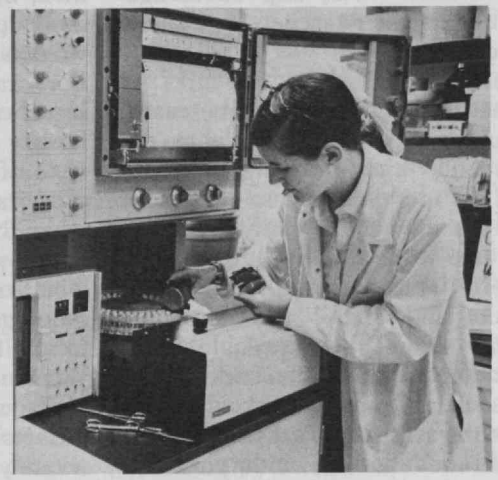
Ellen H. Swallow, '73, M.I.T.'s first alumna, remained throughout her active career a teacher in chemistry at the Institute; by 1911, upon her retirement, she was considered "the foremost authority of her sex in the world" in food and sanitary chemistry.

First as Miss Swallow and later as Mrs. Robert H. Richards (her husband also had a distinguished career at M.I.T.), she was a champion of women in science and at M.I.T.; she was sensitive to her pioneering role as a student and teacher at the Institute and both concerned and amused by the foibles she occasionally encountered. In 1871, for example, there was concern in the M.I.T. faculty about whether, as a woman, Miss Swallow's name should be listed in the catalogue among the special students. The decision finally made, Miss Swallow wrote her parents, "Do you wish a (catalogue) this year with *my* name in alphabetical order among the other students? This is quite a triumph for a woman, isn't it?"

Soon after graduation Miss Swallow was asked to organize a "women's laboratory," a special facility through which women were able to fulfill their laboratory requirements because men's laboratories were inadequate (top photograph). The group picture shows M.I.T.'s women students in 1888—with Mrs. Richards at the left end of the back row. The other photographs show looms manned by women students in the M.I.T. School of Design late in the 1800s, Professor William T. Sedgwick lecturing to a class which included at least one coed *circa* 1900, and a laboratory course for which Katharine Dexter McCormick ('04) was enrolled in 1903.

The modern scenes (right) suggest that women's roles at M.I.T. have changed substantially by the last quarter of the 20th century, though the accompanying articles make it clear that the professions of science and engineering have changed far less. Today the Institute has over 700 women registered for undergraduate and graduate study, and women will be the largest proportion (perhaps 15 per cent) in history of M.I.T.'s entering class in September, 1973. (Photos left from M.I.T. Historical Collections, right by Margo Foote)






LODISH

of their male colleagues. Nor is there any evidence that the graduate education of a woman is "wasted since she will soon give up her career to raise children." A study by H. S. Astin of women doctorates in various fields showed that 91 per cent continue to hold professional jobs, 80 per cent without interruption. A recent study of the American Physical Society reports that, of physics doctorates granted their degrees between 1935 and 1968, a lower limit of 80 per cent of the women are still active in physics, compared to 94 per cent of the men.

Financial aid is a second deterrent to women wishing to enter graduate school. Despite the fact that women come to graduate school more highly qualified than men, men are favored in the awarding of financial aid. For example, in 1965 49 per cent of all male graduate students in all fields were receiving financial aid while only 37 per cent of the women were given financial support; and in many institutions it is clear that women tend to receive a higher percentage of the smaller awards. Discrimination in the awarding of financial aid was made illegal by the 1972 Higher Education Act. Universities must insure that scholarships and assistantships are given solely on the basis of the qualifications of the applicants; sex, attitudes about future "risks," and spouse's earnings are irrelevant.

Attrition during the graduate years is a third major factor in the lower proportion of women than of men completing doctorates. The attrition rate among doctoral candidates is higher for women than men, and a greater proportion of women than men students leave graduate school with a master's degree. The major reason is family responsibility. There may be a special problem here for science students: their work is often experimental and may involve long and erratic hours in the laboratory, and this makes family responsibilities especially difficult.

Part-time graduate study while raising a family may be a partial solution to this problem, yet this is difficult at present because most scholarships and fellowships are limited to full-time students. Part-time students now also tend to be pushed to the edge of the graduate student group and may move along even more slowly because they lack contact with, and encouragement from, their teachers and fellow students.

We urge that these pressures on women graduate students be eased. Regulations of both graduate departments and granting agencies must be more flexible so that older students may more easily return to graduate work after raising families. Maternity and parental leaves (both female and male) of reasonable length should be available with guaranteed re-admission and without jeopardizing financial aid when the student returns. Part-time study should be allowed, with part-time students receiving part-time financial aid and full university benefits.

A pool of able women undergraduates exists. They should be encouraged to work to their full potential and to consider seriously graduate work and scientific careers. Science departments should examine their graduate admissions policies and make major efforts to recruit women students, with women faculty members taking an especially active role.

The ultimate goal of science departments should be to award approximately the same proportion of doctorates to women in a particular year as bachelor's degrees were awarded to women in that field five years previously. Clearly, there must be a time lag before this goal is reached, but we feel that if our recommendations on admissions and attrition were carried out, this goal could be reached to the 80 per cent level in five years and completely in ten years at most.

Women on University Faculties

The representation of women in academic institutions follows a significantly different pattern from that for men; there is a history of both overt and covert discrimination against women in the academic community. For example, in U.S. women's colleges, where 74 per cent of the faculty are women, only 55 per cent of the full professors are women. In coeducational institutions women form 31 per cent of the student bodies and 13 per cent of the faculties, with a distribution rank ranging from 4 per cent of full professors to 23 per cent of instructors. Women are concentrated in such nonfaculty positions as research associates and lecturers, and they are severely underrepresented in high-level administrative positions.

These data are true not only for scientific departments, where one might expect to find fewer women, based on the smaller proportions of women graduating in science; they apply to all academic departments, including those in fields where women have traditionally formed a large proportion of the student body. In addition, women members of university faculties are advanced more slowly than men, and they are paid less at every level.

Several factors are responsible for the low representation of women in academic institutions. One of them

is recruitment policies: few faculty positions have until recently been announced, and candidates have been identified on the basis of contacts between faculty and their colleagues in other institutions.

Many professional women are presently excluded from university faculties because of nepotism rules. We acknowledge that in a small percentage of cases problems may arise when two members of the same family work together. But the nepotism rulings in many universities cannot be justified on these uncertain grounds. They should be abolished immediately and replaced, as necessary, by conflict-of-interest rules.

Many faculty rules in academia were written with men in mind. They favor a continuous career; faculty are penalized for interupting their careers for a period of time. In fact, it was once commonly accepted that women who wished to have academic careers would have to sacrifice marriage and a family, and even today many people assume this to be the case.

But women are becoming more and more unwilling to make such a sacrifice. The universities must make it easier for a woman in any position who wants to have both a career and a family. Age should not be a factor in academic appointments; an older woman who chooses to return to her career after having a family should not be barred from appointment at the assistant professor level if her academic qualifications are suitable. Unpaid maternal leave of reasonable length should be available without jeopardy to subsequent promotions. Most important, part-time academic positions carrying full faculty prerogatives should become a normal feature of academic life. (And care must be taken that such "part-time professors" do not become a second class of university citizens—and also that part-time positions do not become associated mainly with women and therefore, by definition, second class!)

Clearly, our goals for the faculties of science departments must be based on the availability of candidate. The existing pool of qualified women is small, but it is not nonexistent; and an increase in the number of women in academic science is essential. It is extremely important that each department with a Ph.D. program have a tenured woman professor who can serve as a role model and advocate for the younger women. Such appointments should be made before the 1975-76 academic year for those departments with more than 20 tenured members, by 1977-78 for departments with 10 to 20 tenured members, and by 1979-80 for those departments with fewer than ten tenured members. This cannot be accomplished unless tenured positions are set aside for women in each department.

In addition, each department should appoint women to assistant professorships so that the percentage of assistant professors who are women becomes equal to, or greater than, the current percentage in the postdoctoral pool—those who have received their degrees within the previous three-year interval. For example, a physics department with 30 assistant professors should have at least one woman assistant professor, since the percentage of Ph.D.'s receiving degrees in physics between 1969 and 1972 who are women is 2.6. A biology department with thirty assistant professors should have six who are women, since the percentage for biology is 20. This level of appointments should be achieved before the 1975-76 academic year and should be adjusted to equal the levels in future postdoctoral pools.

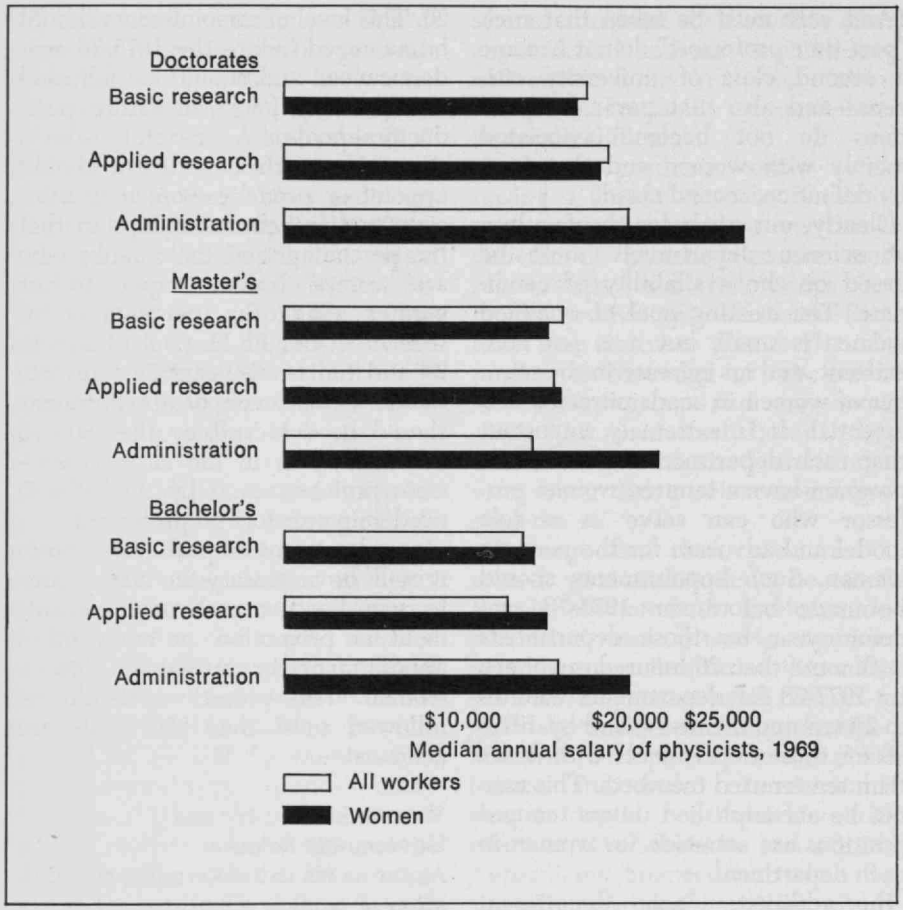
Similarly, each department should appoint or promote women to associate and full professorships so that the percentages of these ranks who are women become equal to, or greater than, the percentages of women in the Ph.D. pool of five to 25 and ten to 30 years ago, respectively. These levels of appointments should be achieved by the 1977-78 academic year in the case of associate professors and by the 1979-80 academic year for full professors.

In order to accomplish these goals it will be necessary in many cases to award either each new appointment or promotion, or every other appointment or promotion, to a woman. This procedure should be followed until the 1980 goals are achieved.

Women in Industry and Government Science

As far as we can determine, the situation of women scientists in industry and in government or national laboratories is very similar: there are relatively few women; they are mostly in research or lower management ranks, and—particularly in industry—they are likely to be paid less than men of equivalent rank.

Women biologists, chemists, and physicists are represented in about the same proportion in government laboratories as in the fields as a whole, but comparison of salaries for men and women scientists in government laboratories reveals marked discrepancies: women chemists employed by the federal government, for example, earned salaries equalling 80 per cent of the average



Government laboratories pay physicists essentially the same salaries no matter whether they are men or women—except for those who take on management or administrative responsibilities. Only 5 per cent of women Ph.D. physicists in government laboratories are in administration, but 27 per cent of all such physicists hold such assignments. (Data: 1970 Register of Scientific and Technical Manpower)

salary of all chemists in government laboratories. Beyond these figures, we have been able to find detailed data only for the case of women physicists, but it is probably not unreasonable to assume that the situation for other women scientists is comparable to that for women physicists.

The American Physical Society's Committee on Women in Physics found that women physicists in government and national laboratories "are happy with their jobs and are better treated than in other sections of the physics community." But job stratification was found: 64 per cent of the women Ph.D.'s in government laboratories described their work as basic research, while only 10 per cent were in applied research and 5 per cent in administration or management. These figures compare with this distribution for the total sample of men and women: 48 per cent in basic research, 19 per cent in applied research and 27 per cent in management. Median salaries for women Ph.D. physicists in basic or applied research did not differ significantly from the salaries of the total sample, but salaries were markedly less for women Ph.D.'s in management positions.

Only 9 per cent of women physicists are employed in industry, compared to 27 per cent of male physicists. Among the non-Ph.D. women physicists in industry, 42 per cent consider their prime activity to be research, 29.5 per cent writing or editing, 8.1 per cent teaching, and only 7 per cent management or administrative. This latter figure compares with about 25 per cent for non-Ph.D. male physicists. In 1970 the differential between the salaries of Ph.D. men and women physicists in industry was 8 per cent in favor of the men. The equivalent figures for master's and bachelor's physicists were 16 and 23 per cent, respectively, both in favor of men.

A detailed analysis indicates that a major part of these differentials comes from the higher salaries received by men in management and administration. There are strong indications that all these differentials are due in large part to discriminatory hiring practices. Companies are well known for their reluctance to hire women at responsible levels; women, with their complications of marriage and children, are traditionally not considered a "good risk" in a commercial enterprise.

This myth is refuted by the Physics Committee, which found that only

14 per cent of the women physicists had been with their employers less than two years; 36 per cent had been with their present employers for two to four years, and as many as 3.5 per cent had been with their employers over 20 years.

The majority of industrial firms now allow unpaid materinity leave, and about half of the firms contacted by the Physics Committee allow part-time work. Very few firms admitted to having explicit nepotism rules, although there are indications that such rules exist implicitly in many instances. Yet the Physics Committee report found that "unfair differences in salary and advancement exist between male and female physicists in industry. It is clear that there are also discriminatory practices in hiring."

Federal legislation enacted since the Physics Committee report was written should do much to abolish the inequities that women scientists presently suffer in industry. But if the aspirations of women scientists in government and industry are to be met within the framework of these institutions, it is perhaps most crucial of all that women function in positions of power within them. Equity of salary levels is one manifestation of power; a more important goal is the placement of women in decision-making and policy-making roles.

We urge, then, that all management training programs be open to women, and that all institutions and companies should aim to have the percentage of women in management and administrative positions equal to the percentage of women scientists employed by their laboratories by September, 1975. And the number of new positions available to women in a particular field should at least equal the percentage of women graduating in that field averaged over the previous three years.

Fellowships, Grants, Contracts, and Committees

The slender evidence available indicates that women scientists receive fewer grants and fellowships than would be predicted on the basis of their representation in the total pool of scientists. According to information on doctoral and special fellowship applications made to the National Institutes of Health during 1970, the rate of disapproval for those for women was 55.7 per cent, while the rate for men was 38.8 per cent. The approval of applications for research career development awards in one granting institute of N.I.H. for the time period 1949 to 1965 showed similar inequities: among women 70.8 per cent were turned down but among men only 21.9 per cent. Similar information has been cited for National Science Foundation awards.

Clearly the awarding of fellowships, grants, and contracts should be regardless of sex, and if it were one would expect to find the approval rate essentially the same for male and female applicants. In a given year, for example, the number of postdoctoral fellowships awarded to women in a field should be in proportion to the number of women Ph.D.'s graduating in that field within the previous few years. We also urge that part-time postdoctoral positions be supported, and that part-time senior faculty be considered for awards of research contracts.

Government scientific advisory committees, like the bulk of the decision-making apparatus in government, industry and academe, are heavily populated with men. The desirability of including women in these policy-making structures cannot be overstated.

We consider that qualified women scientists should be appointed to advisory committees both to further their own development and to contribute to the establishment of goals and policies for scientific organizations. The policy of H. E. W. should be extended immediately to other committees that review grant and contract applications and establish policy for federal institutes. Our goal is that all scientific advisory committees should contain at least 30 per cent women by 1975.

The reader will probably realize that some of the goals listed in this article have already been achieved, at least in theory, as a result of recent legislation. This is extremely encouraging. However, we note the unfortunate fact that the act of passing a law does not immediately assure that the now-illegal practices end. Indeed, if this were an ideal world and all laws were fulfilled there would be no problems of sex discrimination and this report would not have been written.

Similarly, we recognize that there is no point in achieving goals for girls in high school, for example, unless we can assure equal opportunities for them later in the professions. Nor will we achieve our ultimate goals for the professions unless we can encourage more girls to become scientists. We must make progress on all fronts simultaneously. An appreciable start toward the goals discussed in this article will result in a self-sustaining reaction.

Trend of Affairs

Trends This Month

COMPUTERS

Computers from the Window Factory

Nothing like the statistical detail on computers in the Western world is available for Iron Curtain nations; bookkeeping systems are different, hardware is different, and many doors open only with apparent reluctance.

Such glimpses as can be had suggest that the Russians may have squandered their early leadership in data processing and the Chinese, dependent upon Russian technology until 1960, may now be assuming a leadership role. But the penetration of electronic data processing into the government, military, and industrial life of these nations remains primitive, essentially nonexistent.

Patrick J. McGovern, President of International Data Corp. told the Institute of Electrical and Electronics Engineers at its spring meeting of a Rand Corporation report: as of last May, said Rand's *Soviet Cybernetics Review*, the Russians' "protracted, costly effort to build third-generation machines on a par with those of the West has been considerably less than successful. . . . Speculation is developing that government and Party leaders have come to the realization that something is very wrong in the computer industry."

Chinese: Conservative and Competent

In contrast, a member of a team of American visitors reported that they found the Chinese computer experts well informed and Chinese computer design and components "conservative" but competent (the Chinese ability to manufacture high-performance integrated circuits is "an impressive accomplishment," the visitors reported).

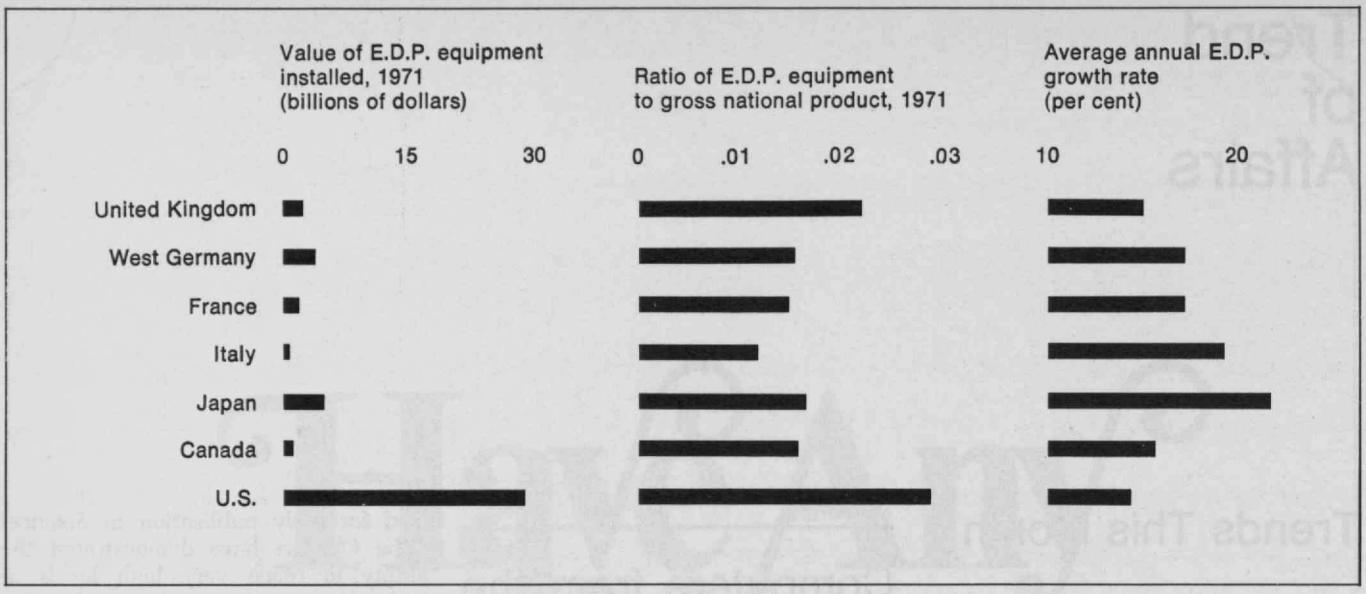
Servero Ornstein, Senior Systems Designer at Bolt, Beranek and Newman, Inc., cautioned I.E.E.E. members about evaluations of the form, "China is *n* years behind the United States." His reason, quoted from a paper scheduled for early publication in *Science:* "The Chinese have demonstrated the ability to reach very high levels of technology in a very short time. The state of technical and scientific knowledge is expanding rapidly. Much will depend on Chinese present and future national priorities and on the broadening base of interaction with the Western world." Judgments of Chinese computor progress are difficult: contrasts within the country are immense and laboratories varied—some primitive, some very advanced; but in general Dr. Ornstein describes the quality as "excellent."

Here are some highlights of Dr. Ornstein's report on behalf of a group of six American computer scientists who visited China at that government's invitation in July, 1972 (the other visitors were Thomas H. Cheatham, Jr., Director of Harvard's Center for Research in Computing Technology; Wesley A. Clark of Cambridge, Mass.; Anatol W. Holt of Massachusetts Computer Associates, Inc.; Alan J. Perlis, Professor of Computer Science at Yale University; and Herbert A. Simon, Professor of Computer Science and Psychology at Carnegie-Mellon University):

☐ Computer design and development is centered in several computer institutes operated by the Academy of Sciences; two, in Shanghai and Peking, claim about 1,300 members. Universities have at best a secondary role.

☐ The most famous computer factory in China is the "window handle factory" in Peking, so named for the products which it earlier produced. Here, and in the more advanced factories elsewhere, manual assembly methods seemed to predominate. Though their guesses range widely, the visitors think that they saw facilities capable of producing perhaps 100 computers a year; but their tour was by no means comprehensive.

☐ Integrated circuits have been made in China since 1968, and Professor Cheatham thinks the Chinese are ahead of the Russians in this tech-



The world's stock of computers in use totalled $50 billion at the end of 1972, and Patrick J. McGovern, President of International Data Corp., thinks it will rise to $100 billion by 1977, a growth rate of 16 per cent a year. Over half of today's computers are in the U.S., but the computer usage is growing faster in Europe and Japan—so fast in Japan, in fact, that by 1977 the Japanese will be using over one-third as many computers as all the West European nations combined.

nology. Indeed, Professor Cheatham in an earlier report in *Computers and Automation* (November, 1972, pp. 16-17) described Chinese work in the whole field of computer science as "far more advanced than American experts had thought." There was even evidence of large integrated circuits at the "excellent" facilities of Tsinghua University. Ferrite-core memories are in "common use," and memories using ferrite rods and magnetic films were seen. Printed circuit boards were common.

☐ Chinese computer design is "conservative." But everywhere the group was asked about large computing machines, and it was obvious that such machines are a major goal of Chinese computer scientists. There was little interest in mini-computers. The next "big push," thinks Professor Cheatham, will be toward time-sharing, and the group was pressed for American experience with problems in this field—having been assured that the Chinese understand the basic concept.

☐ Paper tape is widely used, punched cards not at all. Fixed-head magnetic drums were common; magnetic disc systems were not seen. Line printers, using arabic numerals and Roman letters, were the typical output devices.

☐ Though the Chinese are aware of many possible computer applications, the principal use at present seems to be for scientific and engineering calculations—structural analysis, weather prediction, and lens design, for examples. All general-purpose Chinese computing seemed to be in the batch-processing mode.

Will the Chinese continue their progress in computer science? The Chinese themselves sensed that their biggest problems were in education and in "finding the proper modes of combining theory with practice," said Dr. Ornstein. They seem to be indebted to no one: we were "completely convinced that the Chinese are doing a great deal on their own," he said. But the visitors were impressed with another issue: Can a nation committed to progress without a scientific/technical elite be effective in this extraordinarily complex technology?—*J.M.*

A World Monopoly

The U.S. remains by far the world's largest and most intensive user—and producer—of computers.

Over $29 billion of electronic data processing machines—roughly half of all those in the world—were in use in the U.S. by the end of 1972; that is about 2.8 per cent of the country's gross national product for the year. The average annual growth rate of installed computer capacity in the U.S. in the last decade has been 14 per cent.

In no figure except growth rate does any other nation challenge the U.S. Great Britain's installed computer capacity at the end of 1972 was $2.47 billion, 2 per cent of the U.K.'s g.n.p. for that year; the industry's growth rate is 15 per cent. Higher growth rates are typical of other European nations, the highest being Italy's 19 per cent. Only in Japan, where the saturation is still relatively low (1.6 per cent of g.n.p.), is the growth rate higher: 22 per cent, compounded annually.

The figures come from the files of International Data Corp., whose President, Patrick J. McGovern, described the world computer market early this spring at the annual convention of the Institute of Electrical and Electronics Engineers (see above).

The big lead of the U.S., he said, can be attributed to its large machines—of which there are relatively few equivalents elsewhere. In general Europeans' computer investments are in small machines, programs, and the peripheral equipment for entering and retrieving data. International Business Machines' dominance of the international scene (its market share in Western Europe is 67 per cent) is so great, and its economics of scale in manufacturing and marketing so overwhelming, thinks Mr. McGovern, that "the European computer main-frame manufacturers probably cannot in the long run survive on their own."

Here is how Mr. McGovern characterizes the several segments of the European market: The United Kingdom has the most sophisticated (in Europe) communications and advanced timesharing experience. West Germany "leads in the use of sophisticated data entry techniques but has little in the way of service bureaus and software houses." France, despite the government's continuing effort to develop a domestic industry, shows "little apparent interest in improving computer utilization"—an "enigma," says Mr. McGovern. Italy is in an early stage of computer use, with disproportionately high communications and software costs but a high projected growth rate.—*J.M.*

E.D.P.: Nowhere to Go But Higher

"Computers? Are you out of your mind?"

Several hundred members of the Institute of Electrical and Electronics Engineers at their convention this spring pricked up their ears when David M. Goodman of Goodman and Mautner, Inc., insisted that he had not taken leave of his senses: new developments in computers and electronic data processing are among the best venture-capital investments he knows how to make.

Electronic data processing, he says, will be one of the largest industries in the world by 1980. Already it is the fastest-growing segment of the U.S. economy: $7.7 billion worth of computer systems were built in this country in 1971, and the comparable figure was up 19 per cent in 1972.

Why this unbounded optimism? Probably because, as Harry Weisberg of RCA Solid State Div. said to colleagues at I.E.E.E., the array of solid-state devices and products which have been developed in the U.S. in the last 25 years, since the invention of the transistor, is "almost unbelievable." America's lead in the field remains unquestioned, he said: we have a favorable balance of trade in solid-state devices with every major country of the world, and only one significant new solid-state application—the tunnel diode—has been developed without reliance on American innovation since 1948. Semiconductors are one of the few areas of electronics in which the Japanese had a negative (by $16 million) trade balance in 1970.

How long can American supremacy continue? As long as we maintain the edge in innovation. Examples: the new integrated-circuit pocket-size calculating machines, integrated-circuit devices for automobiles (for example, controls for ignition and electrical systems); and solid-state timepieces.

Should the U.S. restrict sale of its high-technology devices to thwart would-be imitators? No, said Mr. Weisberg; indeed, he answered the question with another: "Is there really any proprietary technology today?" He thinks that idea may be obsolete because the diffusion of technology from one company to another is now very fast—as fast as one man can move from one employer to another.

The time scale is longer—but shortening—in international markets. In the 1950s, said Mr. Weisberg, the lead time between American invention of a new high-technology device and "aggressive foreign competition" in its manufacture was over three years, plenty of time for U.S. makers to gain the kind of experience they needed for efficient production of reliable devices.

The lead time is still being eroded—it is now perhaps only one year. But that's still long enough for innovation to pay off—handsomely, thinks Mr. Weisberg.—*J.M.*

MOON AND STARS

Sedimentation on a Dry Planet

If Mars is dry—or nearly so—how shall we account for a series of layered terraces which photographs show stretching hundreds of kilometers across the planet's polar surfaces?

Here is how James Cutts of Caltech's Jet Propulsion Laboratory developed his answer to that question at an M.I.T. spring seminar:

☐ Though one is struck by the "extraordinary uniformity" of the terraces upon first seeing Mariner photographs, detailed study reveals variations in their thickness of the order of 5 meters in 30.

☐ One is also struck by the absence of cratering in the terraces. The terrace surfaces are young, but a few craters reveal that the surfaces are not entirely new.

☐ The terraces are near the polar regions. Toward the equator we find very different, large, deeply sculpted features—mountains and canyons—which seem most likely shaped by wind erosion.

Given these observations, said Dr. Cutts, one seeks a mechanism for the movement of dust from the equator to the poles of Mars, and for its layered deposition.

The former is simple: Martian wind velocities are far greater at the equator than at the poles; dust picked up at the equator would naturally be deposited at the poles.

The terraces are large and thick enough to contain 5 million km.^{3} of dust—a layer 300 meters thick stripped from the whole surface of the planet. It is more than chance, thinks Dr. Cutts, that the deeply sculpted features in Mars' equatorial regions represent a volume of 300 million km.^{3} removed from a plain surface, an amount of material only a few orders of magnitude different from that computed to be in the terraces. Now, said Dr. Cutts, he is satisfied that this identifies a source, sink, and transport mode.

But why is the dust set down in layers?

The Martian atmosphere is composed largely of CO_2. To form the caps of frozen CO_2 which appear each winter, the atmosphere must quite literally collapse to the Martian surface, carrying along much airborne dust.

But such large features as the terraces cannot be explained on the basis of this one-year seasonal cycle.

How about the large-scale changes in the Martian climate which result from perturbations in Mars' orbit around the sun?

It is to this variation that are attributed the great dust storms such as the one encountered by Mariner 5 upon its arrival at Mars, and it is to this same cyclical variation that Dr. Cutts now assigns the polar terraces: the dust appears not continually, but in yearly increments.

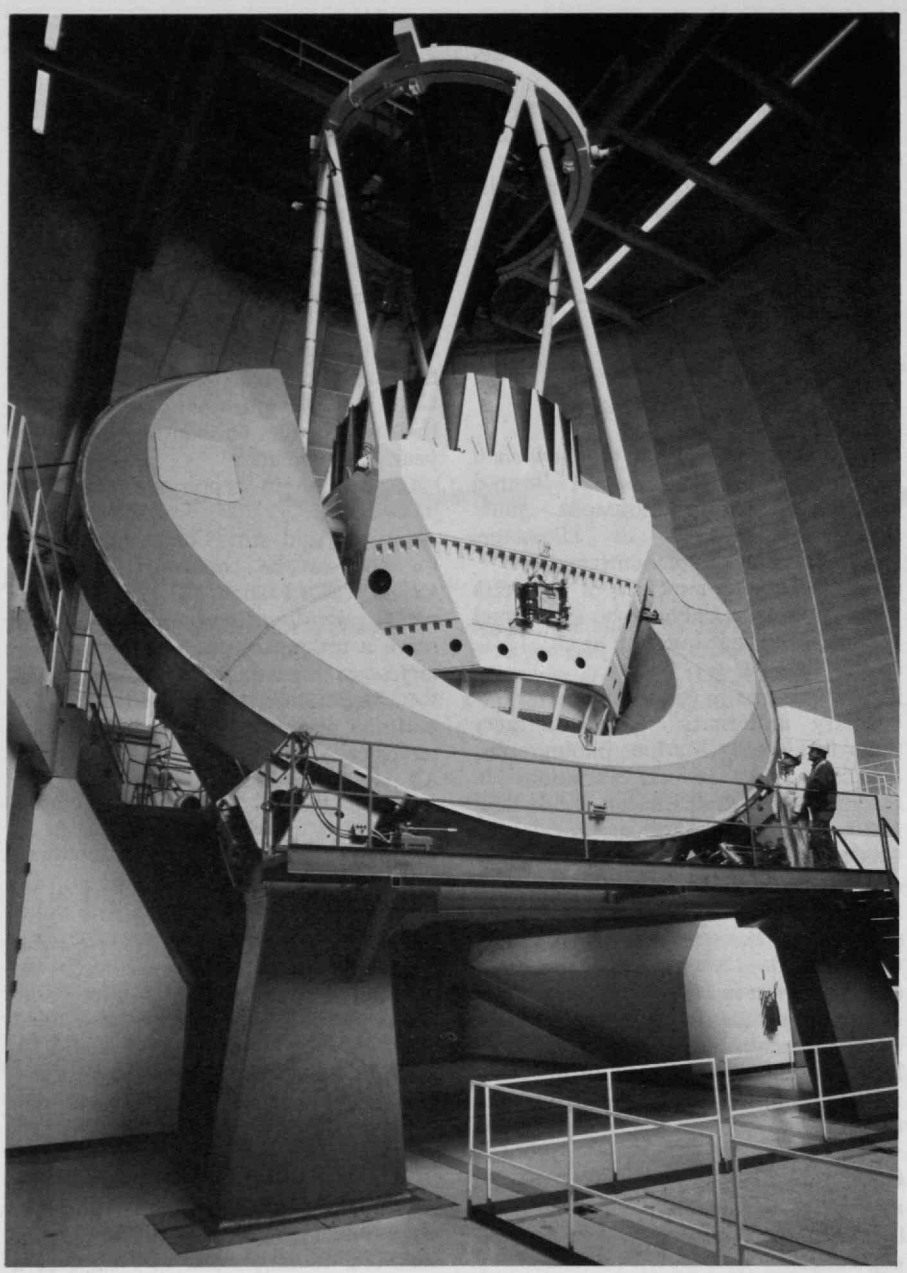
An exercise in geophysical logic for its own sake?

Not so, said Dr. Cutts. For if the terraces can be confirmed as a historical record such as layered sediments provide on earth, they may preserve a unique record of Martian geologic and climatic history. Changes in the sizes of the polar caps? Changes in patterns of erosion? Changes in solar intensity? Changes in planetary orbits? All of these—and perhaps more as well.—*J.M.*

Kitt Peak: Last of the Super Scopes?

By the end of this year, the latest large telescope, the 158-in. reflector of Kitt Peak National Observatory, should be more or less routinely workable atop a 6,900-ft. mountain near Tucson. Actually, it has been in a sort of shakedown mode since last winter; the 15-ton oval of fused quartz glinted with its initial light—its first in-focus vision—late in February. Fanciers of historical footnotes may be impressed by the coincidence that this event transpired almost precisely five centuries (five-hundred years and twenty-seven days, to be acute) after the birth of Nicolaus Copernicus. They might, on the other hand, be more intrigued by the possibility that, except for a duplicate now near completion, no more mirrors of such bulk may be fabricated in this country.

Design of the new tool was initiated in 1961 by the Association of Universities for Research in Astronomy (A.U.R.A.), the 12-institution consortium that operates the Observatory for the National Science Foundation, and the mirror blank was ordered from General Electric three years later. "The long eyes," as the Arizona astronomers are known to their Papago Indian neighbors, kneaded some novel concepts in their blueprinting. In order to avoid winds and rise above ground-level turbulence, the instrument is perched on a stilt-like arrangement—



The newest in supporting structures for telescopes—that for the Kitt Peak National Observatory which will begin service this year. The 158-inch lens rests upon a "flip secondary", the large horseshoe-shaped structure shown in the picture. This insulates it from turbulence and makes moving it from one operating position to another quick and easy. (Photo: Kitt Peak National Observatory.)

inside a cylindrical concrete pier the height of a 19-story building. A "flip secondary," a huge ring that holds a camera on one side and secondary mirrors on the other, allows the telescope to be moved quickly from one operating position to another.

For the time being, the Nicholas U. Mayall Telescope, named for a retired Kitt Peak director, is smaller only than the 200-in. Hale Telescope on Mount Palomar in California—a distinction it will forfeit once the Soviet Union finishes in the Caucasus Mountains, at Zelinchuk, one that is said to have a 236-in. diameter.

Because telescope technology has pushed considerably forward in the three and a half decades since its Palomar ancestor was put to work, the Mayall reflector offers some advantages. Its field of view, for instance, is six times wider than that of the Hale (which cost about $25 million in 1948 vs. $10 million for the Mayall), meaning that a single photographic plate will provide forty times more sky coverage. Solid state circuitry also enhances its versatility, so that scholars should be able to use it in more ways. With it, they can, among other things, focus on feeble pulsars and quasars and obtain a closer picture of distant galaxies—"look back," as Associate Director Arthur A. Hoag has phrased it, "to the first light of creation."

A.U.R.A. now is grinding in Tucson for its Cerro Tololo Inter-American Observatory in Chile a mirror that essentially will be a twin to that on Kitt Peak—identical save for the fact that it was fashioned from a vitreous ceramic (Cervit, which also is used for stovetops and pots and pans) with a virtually zero coefficient of expansion. The ceramic should be in place in Chile in 1975.

Whether still more massive telescopes may yet be built in the United States, or even others of this size, no one can predict. Nonetheless, astronomers no longer talk hopefully, as they did a few years ago, about a gargantuan "*X-inch*" eye. Part of the explanation is fiscal, for astronomy has fared no better than the other disciplines beset by receding grants. The main reason, though, is that there now are alternatives to the construction of larger and larger reflectors. Optical astronomers hope to adapt to their own purposes one alternative: the "array" techniques common in radio astronomy. Already, the University of Arizona and the Smithsonian Astrophysical Laboratory are conjuring a network of six 72-in. mirrors on a mountaintop not far from Kitt Peak: each of the six would superimpose on a single, central image much of the light it gathers. Such an array should have the collecting power of a 176-in. telescope—for a much more modest investment. So, many researchers, among them Kitt Peak Director Leo Goldberg, believe that the two A.U.R.A. 158-in. telescopes well could be the last of the giants.—*Carle O. Hodge*

ENERGY

Oil Scarcity: Illusion Made in U.S.A. . . .

There is no shortage of fuels.

But we believe there is, so we are willing to pay more for fuels as if their prices were imposed by nature, not by collusion. But we are wrong: the world has an excess of oil-producing capacity and will have one, by conservative estimate, for the next two decades at least.

What's more, says Morris A. Adelman, Professor of Economics at M.I.T. writing in the winter issue of *Foreign Policy*, a group of timorous, self-abusing oil-consuming nations—chief among them the U.S.—changed by agreement what was a slowly retreating monopoly of oil-producers in 1960-70 into a confident, rapidly advancing cartel in 1971.

The multinational oil companies have become, says Professor Adelman, using the words of Sir Eric Drake, Chairman of British Petroleum, Ltd., a "tax-collecting agency" for the producing countries. Under this arrangement, the companies transferred about $15 billion in 1972 from the consuming countries to the producing ones. And by 1980, if the arrangement continues, the annual transfer will amount to at least $55 billion. By then, Professor Adelman warns, a few Persian Gulf, North African, and Caribbean nations, possessing immense wealth, could "disrupt the world monetary system and promote armed conflict." No wonder the world's oil supply has become insecure, and promises to be more so.

What brought this tremendous flow of economic—therefore political—power to a small coterie of minor nations (which are still minor in almost every way) within a few months? Professor Adelman attributes it to an inept performance by the consuming nations in concert with coaching from their oil companies.

Demand Beyond Supply? Not So!

The world petroleum market was behaving normally enough in the 1960s. Multinational companies were competing for markets which no one of them could control, crude oil supplies were excessive, and the price per barrel of crude at the Persian Gulf dropped slowly from $1.45 in 1963 to 92 cents early in 1970.

Then came a series of unrelated developments contributing to a common result: the Suez Canal was closed and world tanker demand surged; a temporary shortage of refining capacity struck Europe and Japan; Syria blocked the trans-Arabian pipeline and demanded an increase in transit-right payments; and Libya, located west of the Suez Canal ordered a production cutback to support its demands for higher taxes and royalties on crude.

None of these events affected the cost of drawing crude oil from the sands of the Sahara and Saudi Arabia. But they combined to put refiners and retailers under pressure, and prices rose as if oil were in fact in scarce supply. So when representatives of the major consuming nations met in Teheran with representatives of the oil producing nations (the Organization of Petroleum Exporting Countries—O.P.E.C.) in 1971, the latter easily enough gained an increase in royalty and tax payments of about 47 cents per barrel of crude, effective in June, and the promise of further increases to 66 cents per barrel by 1975. It was the beginning of a new era in the crude oil market, says Professor Adelman—with prices we didn't need and payments we didn't have to make.

"The unanimous opinion issuing from the companies and governments in the capitalist, Communist, and third worlds," writes Professor Adelman, "is that the price reversal of 1970 and 1971 resulted from a surge in demand. . . . The story has no resemblance to the facts," which are that between 1970 and 1972 the rate of increase of world crude consumption was down to half of the 1960-to-1970 average. In a truly competitive market, that kind of faltering demand would have sent prices downward, not upward.

The Ritual: Strength Breeds Strength

The crucial event, thinks Professor Adelman, was the consuming nations' capitulation in Teheran, and it was unnecessary. Many of the O.P.E.C. countries were themselves weak then: under real pressure from the consumers "their unity would have been severely tested and probably destroyed." Indeed, he claims that the Shah of Iran, after a conference with the U.S. Undersecretary of State, admitted that "if the oil-producing countries suffer the slightest defeat it would be the deathknell for the O.P.E.C."

Professor Adelman thinks there is evidence that companies and governments agreed, before the negotiations, to opt for higher payments in return for guaranteed supplies—an "advance capitulation," he calls it. "The O.P.E.C. nations now had a signal to go full speed ahead because there would be no resistance."

They did just that. By August, 1971, dollar devaluation spurred more O.P.E.C. demands, and the ritual began: the consuming nations' companies made their offer, the O.P.E.C. governments refused it and broke off talks, the companies made a better offer, taxes were raised again—and crude oil prices with them. So it is that ever since the Teheran agreement, says Professor Adelman, there has been "unparalleled (economic and political) turbulence" in the international petroleum markets and in the oil-producing nations.—*R.S.*

. . . and Treatable by U.S. Action

Must confusion, inflation, and international mistrust be the way of the future in the world's crude petroleum markets? Must the U.S. simply submit to the increasingly effective stranglehold of the O.P.E.C. nations (*see above*) as its reserves of domestic crude are slowly depleted?

No, writes Morris A. Adelman, Professor of Economics at M.I.T., in the winter issue of *Foreign Policy*. "Simple and elegant tactics" are in fact available to the U.S. government.

The principal suggestion: let U.S. tax laws be changed so that taxes paid by U.S. oil companies to foreign nations are no longer deductible for U.S. corporate income tax purposes. U.S. oil companies would suddenly find that their after-taxes net depended on sharp negotiating as well as on an assured supply, and with present O.P.E.C. taxes their stockholders would press them to move out of the crude oil marketing business. The O.P.E.C. nations would soon enough be left to market their own crude at whatever prices they could get.

Surely the O.P.E.C. nations would under these conditions try to hold their monopolistic position, but Professor Adelman thinks they could not. Two reasons: the supply of available crude is in fact very large compared with present world consumption; and behind what the consuming nations view as O.P.E.C.'s confident, malevolent face are some deep mistrusts, ethnic rivalries, and political insecurities. Under conventional market pressures, the O.P.E.C cartel could "break down in a stampede for the exit," thinks Professor Adelman.

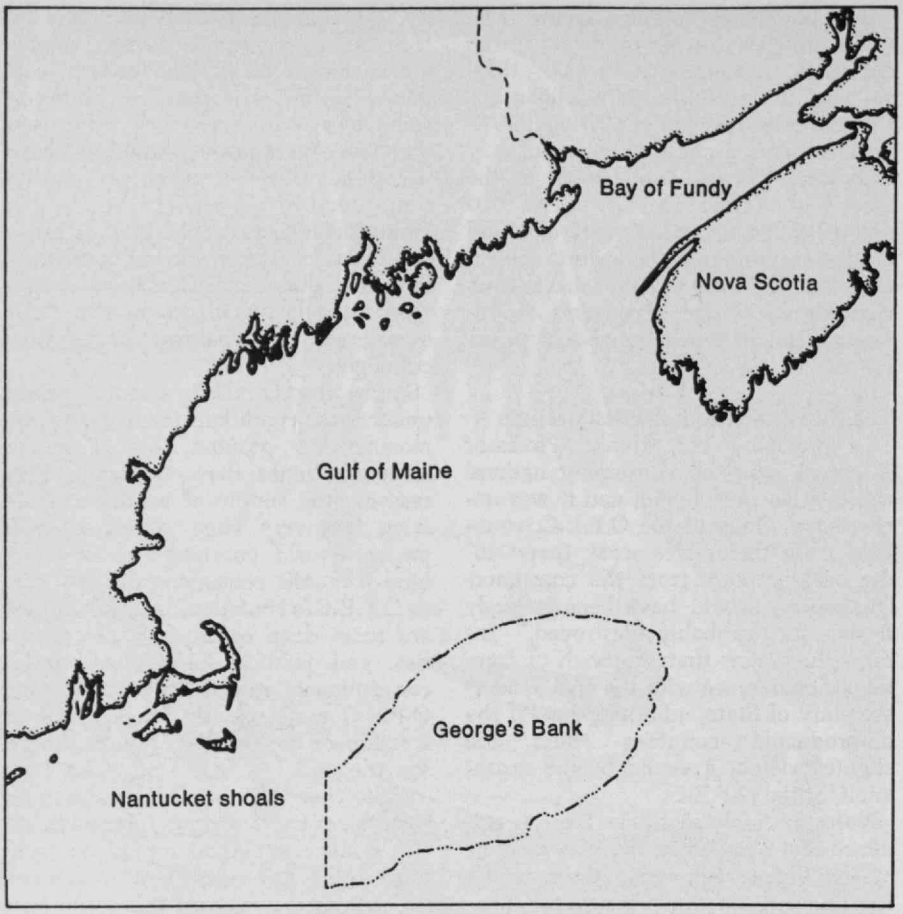
What then? If the O.P.E.C. nations themselves try to operate their oil fields, the result will almost surely be technical mismanagement and a genuine oil shortage. The preferred scenario is this: let the consuming nations' companies contract with the O.P.E.C. nations for the production of crude, which upon reaching the surface becomes the property of the O.P.E.C. governments; and let those governments, in turn, contract on the open market for the sale of that crude to the highest bidders, who would transport, refine, and market it.

The problem, of course, is that implementing this plan requires agreement of all the consuming nations; a U.S. departure from the crude oil business would do no good if the same role were assumed by other consuming nations. And if the O.P.E.C. nations are a disparate bunch, what about the consumers—Russia, the Common Market, Japan, the U.S. . . .—*R.S.*

. . . and Oil at Sea

If the world's crude oil market is full of irrationalities (*see above*), that small part of it that has to do with ocean transport is no exception. Indeed, thinks Zenon S. Zannetos, Professor of Management at M.I.T., it may be the most neglected and misunderstood aspect of an energy enterprise which has otherwise made remarkably effective use of technology and economic analysis to maintain its profit position.

Assuming that world oil demands rise as predicted, Professor Zannetos foresees a world oil tanker fleet of about



Georges Bank, where deposits of oil may be located, sits directly off Cape Cod. A team of oceanographers, engineers, and economists has completed a model of both the environmental and economic effects upon New England, should oil be found and drilled for—perhaps the first model of such a possibility to involve both. A large find would, as expected, be financially beneficial to the area, the model predicts—and probably cause little environmental damage.

450 million deadweight tons by 1980, of which 312 million dwt. will have to be built in the next eight years. The cost, at current rates: $47 billion—not a large sum when compared with the oil companies' total current and projected capital demands; but the oil industry already foresees capital shortages in the next decade, and transportation has never ranked high in terms of its budget or management priorities.

Here begin a series of complications and conundrums, Professor Zannetos told the members of the energy conference at M.I.T. late last winter.

☐ Transportation cost has a higher leverage on energy cost than most analysts have recognized in the past. Indeed, the cost of tanker transportation at the "spot rates"—single-voyage charter rates—has often been higher than the value of the oil cargo carried. (That rate applied to only a small part of ocean-borne oil; most tankers are operated by oil companies or under long-term charters, and rates are far lower, and less volatile, than those for single charters.)

☐ Market conditions and construction time lags are such as to reinforce each other in a "complex network of dynamic interdependencies," said Professor Zannetos, which result in " 'feast-or-famine' cyclical patterns" in tanker supply and demand. This in turn is another source of instability in the international crude market.

☐ The largest part of the new money needed for tankers between now and 1980, thinks Professor Zannetos, will come from the Middle Eastern oil producing countries, whose tax and royalty income is now accumulating at the rate of $25 million a day—another point of leverage for O.P.E.C. (*see above*).

One more factor that contributes irrationality to the oil transportation market, from J. G. Hale of Queen Mary College, University of London:

Large tankers are far more economical to operate than small ones, but the price of transporting oil is a constant per ton-mile, so the large ship has considerable advantage for its owners. And this effect is multiplied by the fact that port facilities for super-tankers, the most profitable of all, are likely to be provided not by the shipowners or by other private enterprise but by government investment. The people whose government makes this investment will have little to gain; the advantage will go to the shipowners.—*J.M.*

Oil off New England?

New England has no oil wells and no oil refineries. It gets all of its petroleum fuels already refined, by truck or tank. It is dependent for oil and gas upon the likes of Texas, the Gulf of Mexico, and Kuwait.

Some see this state as good; some see it as endangering the prosperity and comfort of the region, and the possibility of a large reserve of oil under the ocean off Georges Bank that might bring offshore drilling and refining plants to New England interests both groups.

To see what the effects of a find off the coast would be, the Sea Grant Program, the New England Regional Commission, and the New England River Basins Commission hired a team of economists, oceanographers, and engineers at M.I.T. to design a computer model to simulate varying conditions of regional growth and of fuel use.

Among the alternative conditions were these: costs of capital of 8 and 15 per cent per year; increases in fuel consumption of 2 and 4 per cent per year; payments to exporters of oil of the December, 1972, price of $1.45 per barrel of medium quality Persian Gulf crude, or a rise to a price of $4.00; a United States import quota keeping domestic prices $1.00 above what the market price would be if there were no quota, and no import quota; a regulatory policy keeping the natural gas price at $.30 per 1000 cu. ft., or no regulation at all; federal or regional control over Georges Bank, with royalties and lease payments going to the controlling government; oil finds ranging from 0 to 10 billion bbl. of oil and from 0 to 10 trillion cu. ft. of gas; and five alternate sites for the terminal and refining complex—a Delaware port as it is now, the same port deepened to take 65-ft. draft tankers, a site in the Maritime provinces, a site at Machiasport, Maine, and one at Dighton, Mass.

The analysis that came from setting all of these alternatives against each other is long and thick. Among its conclusions are the following, all assuming a 2 per cent per year rate of increase in consumption and an 8 per cent per year cost of capital:

☐ The single most important variable influencing the cost of New England's oil is the price per barrel paid to the exporting nation: to go from the $1.45 we pay now to $4.00 (which is projected for 1980) "is equivalent to the region giving up ten billion dollars now on a one-shot basis." The next most im-

portant is the import quota, and then the depth of the receiving port. Deepening the Delaware port would increase regional income by $800 million rather than by the $230 million gotten just from building the refinery.

☐ A goodly find of oil on Georges Bank would add $4.3 billion annually to the regional economy. But if no oil were found a change from a strict import quota to none would by itself add $4.4 billion.

☐ A large find would increase regional income by $200-to-$400 million, if the Bank is federally controlled and gas prices are not regulated. But if gas prices are regulated and the region controls the Bank, regional income should increase by $2 to $4 billion.

☐ A small find under those conditions will add $70 to $300 million to the region's economy.

☐ How much oil is likely to be spilled depends on whether or not oil is mined on the Bank, whether or not oil is refined in New England, and whether any such oil is delivered throughout New England by tanker or pipeline. The range goes from 1.4 million gallons spilled near the shore if no oil is mined or refined to 1.3 million spilled offshore and 1.9 million spilled nearshore if one million bbl. per day are mined, piped to shore, refined in New England, and distributed by pipeline. If the oil is tanked ashore, of course, a spill near the shore is much more likely.

☐ Whether or not a spill on the Bank reaches the shore depends on the season. In summer, a spill would have a 5 per cent chance of reaching land—Cape Cod—and then only after some 30 days at sea. In winter, the chance is close to zero, after some 60 days.

☐ However, a system for collecting spilled oil on the Bank would be "an extremely expensive, hazardous, at best marginally effective, and sometimes completely ineffective proposition."

☐ We still don't know much about the dispersion of spilled oil in the open sea, although the researchers suppose the concentrations on the bottom under the spill would be in the ppb. range. Toxic levels seem to be in the ppm. range.

☐ We have a good idea of what happens to oil spilled near the shore, thanks to the spill in Buzzards Bay, on Cape Cod, three years ago. (*See* Technology Review, *January, 1973, p. 61.*) The oil persists in marshlands for years, completely killing marine life when it washes ashore, and affecting growth there for the duration of its stay.

☐ Even a large spill on the Bank would kill less than 1 per cent of the larvae—the most vulnerable stage of life—in the area.

☐ There is a significant difference in the number of small spills from a well run terminal and refining complex and a "casually run" outfit.—*J.K.*

How Much Energy From Sun and Earth?

When a nation thinks in terms of quadrillions of B.t.u.'s of energy, is it right to dismiss such sources as the earth (geothermal) and the sun (solar) as simply hardly worth the trouble?

Perhaps not. Two new reports prepared under sponsorship of the National Science Foundation suggest that technology has so advanced and energy demand so increased that geothermal and solar energy may be economically available to us in reasonable quantities.

Walter J. Hickel, former Secretary of the Interior, convened a conference last summer for the National Science Foundation on geothermal energy. The group's optimistic report is that in less than 15 years the U.S. could have some 1 billion Mw. from geothermal sources—and 3.1 billion by the year 2000. This anticipates not only further exploitation of such superheated steam resources as are now used in Italy and Northern California (*see "Geothermal—Earth's Primordial Energy," by Richard G. Bowen and Edward A. Groh in* Technology Review *for October/November, 1971*); the conference recommended a $680 million, ten-year research program to study the use of hot water deposits and hot, dry rock reservoirs. If the latter can be tapped, and if deep drilling technologies are available, "a truly immense energy source" may become practical.

No one doubts the abundance of solar energy—43 x 10^9 B.t.u. arrive every day on every square mile of the earth's surface (or cloud cover), on the average. The problem is to convert this diffuse, low-temperature energy into useful work.

A N.A.S.A.-N.S.F.-sponsored study group centered at the University of Maryland now recommends a 15-year research and development investment of $2.275 billion. A successful result could mean that solar energy would provide 60 x 10^{15} B.t.u. of energy a year for the U.S. by 2020, William R. Cherry of N.A.S.A.'s Goddard Space Flight Center told members of the Institute of Electrical and Electronics Engineers this spring at their annual convention. This might amount to 35 per cent of U.S. space heating and cooling needs, using solar heat directly; some 30 per cent of gaseous fuel needs, using solar energy to heat renewable organic materials (algae, plant leaves, and organic waste); and some 20 per cent of electric power needs, by converting solar heat into energy in steam turbines.

"No major scientific breakthroughs are needed to bring about the economic competitiveness of solar energy," said Mr. Cherry. He called only for "the improvement of known materials, processes, and engineering."—*J.M.*

The End for Coal

U.S. known coal reserves are at least 200 billion tons, some 4 quintrillion B.t.u., over a third of the world's total. That is a prodigious supply measured even against the nation's growing greed for energy, and the argument that "coal is the only fuel amply available to cover future needs" is probably familiar to all readers.

But the coal is likely to stay in the ground.

The basis for this position, taken by Professor Richard L. Gordon of Pennsylvania State University at the M.I.T. conference on energy demand and conservation late last winter, is economic: "We have a crowded field and coal must beat all the rivals. Victory here means an ability to be the cheapest-to-use fuel," and Professor Gordon doubts that coal will ever again find itself in that position among the world's competing energy resources.

Oil is clearly today's preferred fuel: it is easier to get and cheaper to move and burn. Coal's disadvantage in the fuels competition stems principally from the fact that coal "is a solid fuel containing large proportions of impurities." It is hard to handle, and the cost of removing pollutants to make coal an environmentally suitable fuel is high—and apparently destined to remain high.

The cost of coal has already advanced from 18 cents/million B.t.u.s in 1969 to nearly 30 cents in 1972. And substantial—probably prohibitive-increases are built into new environmental, mine-safety, and land restoration regulations.—*J.M.*

SCIENCE POLICY

O.T.A.: Assessment, Not Policymaking

The Congress and the people will be best served by the Office of Technology Assessment if it sticks to the job for which it was conceived—which is technology assessment, pure and simple.

It should not try to replace the science adviser who used to reside in the White House, nor become Congress' effort to inherit the powers which formerly resided in that adviser's office.

It should not be the tool of any legislator, or of all legislators together, to attain political advantage.

It should not be a decisionmaker with a bureaucracy of its own, or a policymaker with a position to support.

It should concentrate on being the early warning system, eliminating the "sloppy feedback" which is the best we have heretofore had to help us imagine the results of new science and technology.

Jerome B. Wiesner, President of M.I.T., is often cited as the most likely candidate for chairman of the board which will guide O.T.A., and these are his views, given at an informal luncheon of a "Technology and Culture Seminar" at M.I.T. early this spring.

It is true, of course, that O.T.A. was conceived and created while the Office of Science and Technology was an active part of the Executive Office of the President, and none of its blueprinters expected Mr. Nixon, or any successor, to eliminate the White House science adviser and his staff. Even Ellis Mottur of Senator Edward M. Kennedy's staff, who is given credit for much of the form of O.T.A. and for its successful passage by the Congress, told the *Wall Street Journal* just before President Wiesner's seminar remarks that "if (the President's Science Advisory Council) is not now in existence, an operation like this one [O.T.A.] will become the central science policy institution in the country." He thinks it was "silly" for Mr. Nixon to terminate the Science Adviser's office, and he thinks "the political people in the White House didn't see these implications."

Talk of this kind may be inevitable—but it will not help O.T.A. fulfill Dr. Wiesner's objectives for it.

Two things became clear to Dr. Wiesner while he was with President Kennedy in the White House—and troubled him:

☐ The speed with which science and technology advance, and the speed with which their effects proliferate into society, were faster than he expected.

☐ A closed group within the government was settling issues with broad implications for the whole country—but few people even in the group understood any of those implications.

These two observations made it clear to Dr. Wiesner that something like O.T.A. was needed. No one person who had important insights into the effects of decisions on science and technology could gain public attention until the problem was obvious and its implications clearly serious. And no such person was likely to have the resources to do what really needed to be done.

There were a few obvious exceptions, in which society was warned of possible consequences before they became disasters, which simply proved the point. Rachel Carson's *Silent World* is the most dramatic. When Dr. Wiesner was in the White House as Science Adviser, President Kennedy asked him if Miss Carson might be right—if something should be done; and Dr. Wiesner tried to find a panel of experts to advise him. He needed an O.T.A., he says; it was "almost impossible" to find experts who weren't already involved either in agricultural policy or the chemical industry.

Some other examples: spending $7 billion a year for military research and development has implications for science and technology—drawing talent and funds from other goals, distorting academic teaching and research—which have never really been understood, and they should be. Fifty years ago, when automobiles were first mass-produced, no one imagined that they would destroy our cities. What about the changes in society's mores which have followed increasingly successful contraceptive devices and medications?

"We will always get surprises," said Dr. Wiesner, "but we must try to recognize them early and understand them better. We must recognize that our technological choices define what we shall become, and require that we ask what we want to be . . . . Just raising the issues will help."—*J.M.*

The Willamette River—clean once more. (Photo: Herbert E. Simison)

ENVIRONMENT

A River Safe for Man and Fish

The State of Oregon and the Environmental Protection Agency are pleased to announce that the Willamette River is clean. They express their appreciation to the cities of Salem, Corvallis, Eugene, Albany, and Portland and to the many smaller towns in the Willamette River Valley for installing secondary sewage treatment plants. They also thank the industries in the Valley, most of those in the state, for likewise cleaning their effluents. Oxygen levels in the river, the State and the Agency announce, are now above 5 ppm; in 1967 and before, they were as low as 2.5 ppm. The river, they proclaim, is for its entire 150 miles again safe for swimming.—*J.K.*

A Grifter Meets a Yokel in Las Vegas

Puzzle Corner:
Allan J. Gottlieb

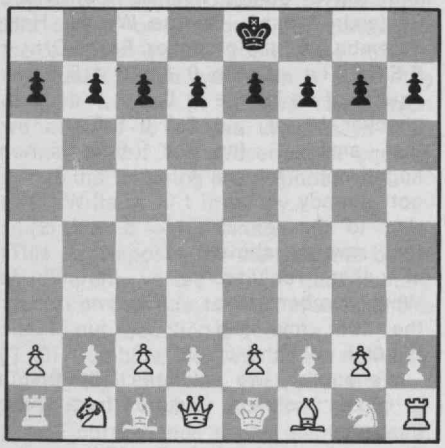
Spring has come again to New England. This was a mild winter, but warm weather and flowers are still appreciated. Yet this has been an "indoors" afternoon, and I am exhausted: I watched "my" Knicks beat the Celtics in double overtime. Alice was really surprised to see that after the game I was sweating and wanted to lie down. Who says television keeps people from being involved?

The first problem in the March/April issue, **M/A1,** is printed with an error: the white rook at KR1 should be removed. As originally printed there is no solution. Please remove the rook and try again; a solution to the revised problem will be given in the October/November, 1973, issue—along with the solutions to this month's new problems. Here they are:

Problems

Harry Nelson asks:

JN1 What is the minimum number of legal moves necessary to reach the following position (either side may move first, and in either direction)?



From R. E. Crandel:

JN2 What is the shortest *curve* bisecting any given triangle?

A number problem from Les Servi:

JN3 If you take a two-digit number, A_1A_2, and subtract the number obtained when you reverse the digits, A_2A_1, you obtain a positive multiple of 5. Divide this number by 5 and you obtain one of the factors of both the original number, A_1A_2, and the reversed number, A_2A_1, Find the original number.

John Bobbitt submits the following; he's a student at Purdue, and the problem comes from a probability course there:

JN4 Two football teams of equal strength compete each year for a cup. The first team to win the game three years in a row keeps the cup. Assume each year's game is independent of the previous year's, and each team has probability $p = \frac{1}{2}$ of winning. What is the probability that a given team wins the cup at the nth trial?

Here's a banana problem, from a reader whose signature is simply not legible (but he's a graduate—S.M.—from M.I.T.'s Sloan School of Management, 1971):

JN5 A camel must carry 3,000 bananas from A to B, which are separated by 1,000 miles. The camel can carry no more than 1,000 bananas on its back, and it eats one banana a mile. How can it arrive at B with the most possible bananas?

Speed Department

Doug Hoylman asks:

SD1 What is the minimum number of pitches possible in a half-inning of a (completed) baseball game?

Here is a modified craps problem from Jack Parsons:

SD2 Carnival. A yokel met a grifter who said, "Here are three ordinary, honest dice. We'll take turns rolling them. Regardless of who's rolling, if one of your points comes up, you win. Now, you're a beginner, so I'm going to give you a break: I'll give you ten winning points and keep only six for myself. And I'll give you odds of three to two." This seemed like a more-than-fair game to the yokel, and they played for a long time. Sometimes the yokel won but more often he lost; in fact, when he studied his score sheet he found that, on the average, he had lost about 19 cents of each dollar he bet. What were the winning points the grifter gave the yokel?

Solutions

The following are solutions to problems published in the February issue:

FEB1 A scrambled sequence of letters is formed by choosing a key word (containing no repeated letters) and writing the remainder of the alphabet in order after it. The letters of this sequence are written as capitals on the 26 cards ♠A through ♥2. The letters of another sequence (based on a different key word) are written as lower case on the 26 cards ♦A through ♣2. On this basis a bridge game, with a contract of four spades held by South, might be written as shown in the box at the bottom of this page. What are the key words?

Walter Penny, who submitted this problem, deserves extra credit: many favorable comments were received on it. Here is John Ribb's solution:

The two key words are "VEXATIOUS" and "copyright." The hands would have been:

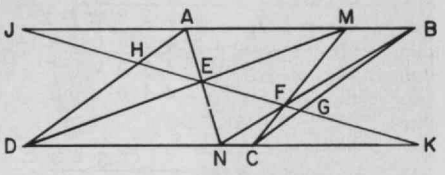
	♠ 6 5 ♥ 9 4 2 ♦ A K J 8 2 ♣ A Q 5	
♠ Q J 10 8 ♥ A K 8 6 ♦ 10 5 ♣ 7 4 2		♠ 4 2 ♥ Q J 10 7 3 ♦ 9 7 6 ♣ 10 9 8 6
	♠ A K 9 7 3 ♥ 5 ♦ Q 4 3 ♣ K J 7 3	

Also solved by Michael Auerbach, James Dotson, Winslow Hartford, Doug Hoylman, Harry Nelson, Charles Rivers, Jr., R. Robinson Rowe, Shou-ling Wang, Benjamin Whang, Mary Youngquist, and the proposer.

FEB2 Given a paralellogram ABCD. Choose two random points M and N on the parallel sides AB and CD. Draw MC, MD, NA, and NB intersecting at E and F. Prove that the line EF divides the parallelogram into two equal areas.

The following purely geometric proof is from Michael Sutherland. A shorter solution would be possible using Cartesian geometry:

The problem is to prove that area ABGH equals area DCHG.



Triangles AEJ and NEK are similar, and triangles AEM and DEN are similar in the same ratio, since AE and EN are common sides. Thus

$JA/NK = AM/DN.$ (1)

Similarly, triangles JFM and CFK are similar in the same ratio as triangles BFM and CFN. Thus,

$JM/CK = MB/NC.$ (2)

Substituting $NK = NC + CK$ and $JM = JA + AM$, equation (2) yields

$JA = CK \cdot MB/NC - AM.$

Using this in equation (1) and solving for CK,

$$CK = [NC \cdot AM(DN + NC)]/[-MB \cdot DN + AM \cdot NC].$$ (3)

Now solving (2) for CK yields

$CK = (NC/MB)(JA + AM).$

Using this in equation (1) and solving for JA,

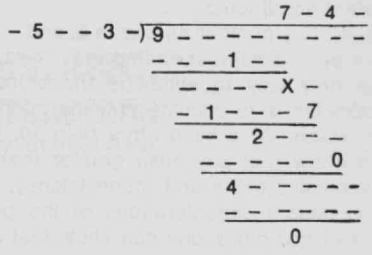
$$JA = [NC \cdot AM(AM + MB)]/[MB \cdot DN - AM \cdot NC]$$ (4)

Since $AM + MB = DN + NC$, $JA = -CK$, or

$/JA/ = /CK/$ from (3) and (4). This implies that triangle JAH = triangle CJK, and that AH = CG. Therefore DH = BG, and figure ABGH is identical to figure DCGH, and the areas are thus equal.

Also solved by Mrs. Martin Lindenberg, R. Robinson Rowe, Gilbert Shen, and the proposer, John T. Rule.

FEB3 Fill in the dashes with digits to make it a correct long division:



A very nice solution is from Raymond Dyba:
The problem is solvable in base-14 number system. There are two solutions differing in the value of X; in both cases the quotient is 7343. The two divisors are 150437 (with X = 0) and 150637 (with X = 8). In the complete solutions shown below, the additional digits required for base-14 are given by y for 10 in the decimal system, z for 11, w for 12, and v for 13.

```
                    7 3 4 3
  1 5 0 4 3 7 ) 9 z 8 w y 7 5 y 7
                9 7 2 1 y 7
                  4 6 z 0 0 5
                  4 1 0 w y 7
                    5 y 2 3 w y
                    5 6 1 3 0 0
                      4 1 0 w y 7
                      4 1 0 w y 7
```

```
                    7 3 4 3
  1 5 0 6 3 7 ) 9 z 9 v 4 1 z y 7
                9 7 3 1 y 7
                  4 6 z 7 8 z
                  4 1 1 4 y 7
                    5 y 2 w 4 y
                    5 6 1 z 0 0
                      4 1 1 4 y 7
                      4 1 1 4 y 7
```

In order to describe the process of solution concisely, label the unknown digits of the divisor d_i and of the quotient q_i, as shown below. Note also that the first digit of the bottom row must be 4 because the bottom row must be exactly equal to the one just above it. We are also given that $d_6 \neq 0$, and from the requirements of the division process we can see that $q_3 \neq 0$ or 1, $d_1 \neq 0$, and $q_1 \neq 0$.

```
                      7 q3 4 q1
  d6 5 d4 d3 3 d1 ) 9 - - - - - - - -
                    - - - 1 - -
                      - - - - X -
                    - 1 - - - - 7
                        - - 2 - - -
                      - - - - - 0
                          4 - - - - -
                          4 - - - - -
                                  0
```

The problem is apparently impossible to solve because

☐ The product of the smallest possible divisor and the smallest possible quotient is larger than the largest possible dividend; and

☐ d_1 must meet two apparently inconsistent conditions:

$4 \times d_1$ = a number ending in 0, and

$q_3 \times d_1$ = a number ending in 7.

The only way to eliminate these inconsistencies is to assume that the numbers are written to a base other than 10. One can show that any base greater than 11 will eliminate the first inconsistency, and from simple considerations of the products of two digits one can show that only in base 14 can d_1 satisfy the two conditions given above, and then only for $d_1 = 7$. One must adopt some convenient symbols for the four digits greater than 9. Then from the requirement that the product of the smallest possible divisor and smallest possible quotient cannot be larger than the largest possible dividend, one can show successively that $d_6 = 1$, $q_3 = 3$, and $d_4 \leq 4$. One can then show from the requirement that

q_1 (1 5 d_4 d_3 3 7) = 4 – – – – –

that $q_1 = 3$; therefore the quotient is 7343. And one can show from the requirement that

7 (1 4 d_4 d_3 3 7) = – – – 1 – –

that d_3 must be an even number. Having with the help of the preceding steps established that

3 (1 4 d_4 d_3 3 7) = 4 1 – – y 7

(where y = decimal 10),

4 (1 4 d_4 d_3 3 7) = 5 – – – 0 0, and

7 (1 4 d_4 d_3 3 7) = 9 – – 1 y 7,

one can substitute into the appropriate spaces of the original problem. Then making use of the only given digit, 2, that has not yet been used, and the requirement that $d_4 \leq 4$, one can avoid an inconsistency only if $d_4 = 0$ and $d_3 = 4$ or 6. One can then complete the entire calculation for both possible values of d_3 separately by working upward to the dividend, and in the process one finds that X = 0 or 8.

Also solved by Christopher Brooks, Richard Dreselly, Raymond Dyba, R. E. Efimba, Winslow Hartford, Fred Heutiuk, Ramchandran Jaikumar, Harry Nelson, Gilbert Shen, and Michael Sutherland.

FEB4 Who drinks water? And who owns the zebra?

1. There are five houses, each of a different color and each inhabited by men of different nationalities, with different pets, drinks, and cigarettes.
2. The Englishman lives in the red house.
3. The Spaniard owns the dog.
4. Coffee is drunk in the green house.
5. The Ukranian drinks tea.
6. The green house is immediately to the right (*your* right) of the ivory house.
7. The Old Gold smoker owns snails.
8. Kools are smoked in the yellow house.
9. Milk is drunk in the middle house.
10. The Norwegian lives in the first house on the left.
11. The man who smokes Chesterfields lives in the house next to the man with the fox.
12. Kools are smoked in the house next to the house where the horse is kept.
13. The Lucky Strike smoker drinks orange juice.
14. The Japanese smokes Parliaments.
15. The Norwegian lives next to the blue house.

	Norwegian	*Ukranian*	*Englishman*	*Spaniard*	*Japanese*
Color of house	Yellow	Blue	Red	Ivory	Green
Pet	Fox	Horse	Snails	Dog	**Zebra**
Drink	**Water**	Tea	Milk	Orange juice	Coffee
Cigarette	Kool	Chesterfield	Old Gold	Lucky Strike	Parliament

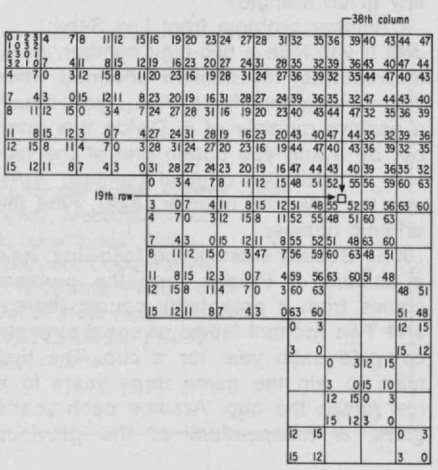
There were many solutions to this problem, including one by architect Toby Hanks, who sent in a model which I cannot figure out how to reproduce. The following less exotic solution is from Mary Lindenberg, who writes that she and her husband found the February *Review* upon returning from a cruise aboard M.S. *Starward,* a Norwegian vessel out of Miami; the headline on "Puzzle Corner" reminded them of their exciting adventure, and Mrs. Lindenberg started working on the problems even before unpacking. Her answer:
The Norwegian drinks the water ("I found this, too, to be true on our cruise!") and the Japanese owns the zebra. The analysis is diagrammed in the box above.

Many readers solved this one: Michael Auerbach, James Bledsoe, Mark Bucciarelli, James Dotson, Carl Estes II, Bruce Fauman, Joann Fray, Marty Geer, David Geisler, Anne Goetting, Jean Goodwin, Winslow Hartford, Denis Hayes, Ronald Jablonski, Ramchandran Jaikumar, Michael McNutt, Dianne Maar, Jerry Miller, Russell Nahigian, Avi Ornstein, Charles River, Jr., R. Robinson Rowe, Mitchell Serota, Gilbert Shen, Deborah and David Smart, Michael Sutherland, Benjamin Whang, George Wynne, Harry Zaremba, and the proposer, Bruce Orr.

FEB5 In each square of an infinite checker board, put the smallest (no negatives) integer not already occurring to the left in that row or above in that column. What number is in the 19th row and the 38th column?

```
0 1 2 3 4 5 6 . .
1 0 3 2 5 4 . .
2 3 0 1 6 . .
3 2 1 0 7 . .
4 . .
. .
.
```

We publish two solutions. The first is a mixed solution picture from Harry Zaremba:
The number which is in the 19th row and 38th column of the infinite matrix is 55. A portion of the matrix is shown below:



The matrix is symmetrical about the principal diagonal whose elements are zero.

Two very different methods are suggested by Gilbert Shen:

Suppose we have an n x n array in the upper left corner of the checkerboard containing only integers 0 through n — 1. Then each row and column will contain all integers 0 through n — 1. Now consider the 2n x 2n array in the upper left corner. Divide this square into four equal quadrants. (The upper left quadrant is our original n x n array.) It is clear that the upper right quadrant will have the identical structure as the upper left quadrant, if the correspondence is made that $0 \rightarrow n$; $1 \rightarrow n + 1$; . . . $n - 1 \rightarrow 2n$. The same is true for the lower left quadrant. Also, the lower right quadrant is identical to the upper left quadrant since the numbers 0 through n — 1 do not occur to the left or above it. This implies that diagonally opposite quadrants are identical to each other and that the 2n x 2n array contains only integers 0 through 2n — 1. Since the assumption is true for $n = 1$ and $n = 2$, by induction it is true for all $n = 2^s$, where s is a non-negative integer. We are to find the value of the element at row m and column p (hereafter called "the element"). We proceed by boxing it in with successively smaller boxes of sides $n = 2^s$. At each step, if the element falls in a lower quadrant, we equate it to the corresponding element in the diagonally opposite quadrant, which then becomes "the element." We shift the corner of the checkerboard to the upper left corner of the quadrant containing the element before subdividing further. Eventually, when we reach $n = 1$, the element will be in the top row (which we observe to be the integers in their normal order). The procedure is equivalent to the following prescription:

☐ (1) Write m — 1 in binary.

☐ (2) Write p — 1 in binary.

(This decomposes the element into boxes of different values of s. Each binary place corresponds to a different s and a step in our reduction procedure.)

☐ (3) Combine the two binary numbers digit-by-digit with an exclusive Boolean "OR" (i.e., 1.0R.1 = 0). A "1" or "0" in p — 1 corresponds to the element being in a right or left quadrant, while a "1" or "0" in m — 1 corresponds to a lower or upper quadrant. The result of the Boolean operation indicates whether or not the origin should be shifted by 2^s.

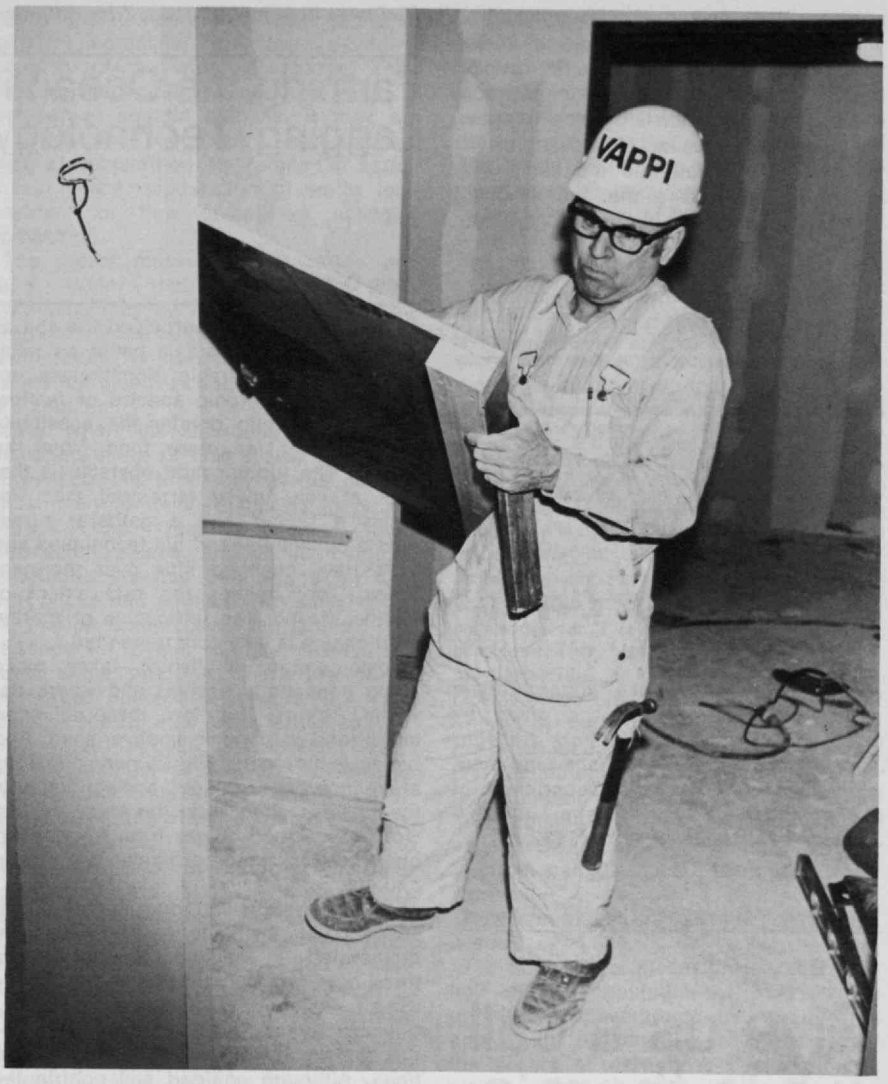
☐ (4) Convert the result back to a decimal number, which is the required answer. For m = 19 and p = 38: (1) $18_{10} = 10010_2$; (2) $37_{10} = 100101_2$; (3) and (4) $110111_2 = 55_{10}$.

Also solved by James Bledsoe, Ramchandran Jaikuma, Dianne Maar, Harry Nelson, Charles Rivers, Jr., R. Robinson Rowe, and Michael Sutherland.

Better Late Than Never

Concerning **O/N3,** Mike Rolle writes as follows:

The geodetic-net puzzle printed recently does not have only the solution printed in February. Your published solution



assumes that only a regular polyhedron will satisfy the conditions given in the problem. However, there are in fact an infinity of solutions. If you think about the problem you can find some of them.

I fear that, as usual, Mike is right. For all it's worth, I fell into the same trap and would conjecture that the proposer intended to imply a regular polyhedron.

Speed Department Solutions

The proposers' solutions to the Speed Department problems above are:

SD1 One. It would occur in the bottom half of ninth inning, score tied, if the first pitch results in a home run.

SD2 The lowest point with three dice is 3; the highest, 18. These are the least probable. The more probable points are grouped around the average of the distribution, which is 10½. So the grifter kept for himself 8, 9, 10, 11, 12, and 13 and gave 3, 4, 5, 6, 7, 14, 15, 16, 17, and 18 to the yokel. This is confirmed by calculating the yokel's expectation:

Point	*Ways*
8, 13	21
9, 12	25
10, 11	27

There are 146 ways to lose and 216 − 146 = 70 ways to win. The probability of winning is 70/216 = 0.325. If the odds are 3 to 2, the expectation is 0.325 x $2.50 = $.81.

Allan J. Gottlieb, whose undergraduate degree in mathematics was given by M.I.T. in 1967, teaches at York College, Jamaica, N.Y. Send solutions and new problems to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y. 11432.

(Columns continued from p. 7.)

Farming the Oceans: Lagging Technology

Carle O. Hodge

People always have perceived the sea as a limitless cornucopia, a belief as fallacious as it is venerable. Nonetheless, because of the chronic spectre of famine, it is important to ponder the possibility of extracting far more food from the waters. The fundamental obstacle is that man at sea, unlike terrestrial man, remains a hunter and a gatherer rather than a cultivator—and his techniques and tools have changed little over the centuries. Too, neither the real extent of marine life nor the intricacies of marine food chains is fully comprehended.

Most commercial fishing takes place along continental shelves and where upwelling occurs. Therefore, these delimited areas tend to become impoverished. And because they generally lie near populous shorelines, our effluent society imperils them. Less than one per cent of the world's sea food comes from the deeper, open oceans, which are relatively barren and inaccessible.

From the statistics, one might almost suspect that the fisheries are developed deliberately to deplete the oceans. In three decades the world catch has nearly tripled. Some of the ecological consequences already are easy to assess, for the oceanic fauna, like all resources, are finite. Although seafood still contributes only a tenth of the animal protein in the global diet, tuna has been over-fished almost everywhere, as have cod and ocean perch in the North Atlantic. The western Pacific has been all but rid of bottom-fish, the Bering Sea of flatfish and the North Atlantic of hake, to name a few. A large sardine industry prospered along the California coast during the 1930s. Owing to intensified pressure from fishermen, coupled perhaps with minor oceanic changes, that pursuit has lapsed, and a less profitable but similar species, the anchovy, has filled the emptied ecological niche of the sardine. In another two decades, virtually no substantial stocks of commercial fish will remain underexploited. A side effect is worth noting: laboratory experiments suggest that when over-utilization becomes severe, the food-web efficiency of the remaining population decreases.

While legislation and international agreements could (but probably will not) curb excesses, the effects of the waste from our industrial civilization are considerably more complex. These effects are not necessarily all negative. Pollution perhaps is the greatest menace to mariculture. Yet, for more than a half century, the sewage of Berlin and Munich has enriched high-yielding carp ponds. Flue gases from a power plant in Dorset, England, are washed with seawater, which, laden with carbon dioxide, is put to use in diatom culture, and the diatoms then are fed to bivalves and shrimp.

Chemical pollutants are another matter. Oysters and other filter-feeding animals may concentrate poisons to levels far higher than those found in the surrounding medium. Anatomically, nature provides fish with scant protection. Mainly because of their gills, they come into intimate contact with whatever may be suspended in the surrounding water; in concentrations of less than one part per billion the pesticide Endrin eliminates many fish. Industrial contamination combined with channel dredging and other marine developments may be blamed for the fact that there has been no consequential natural set of the American oyster in Long Island Sound for more than a decade.

Domesticating Fish

None of these difficulties are likely to be resolved by conventional fishing methods. Trawling techniques certainly will improve. Fish stocks will be hunted and herded with sonar, attracted with mercury vapor lights and concentrated with electrical fields. Still, if seafood production is to grow, there must be other new approaches that are both skillfull and ecologically sound.

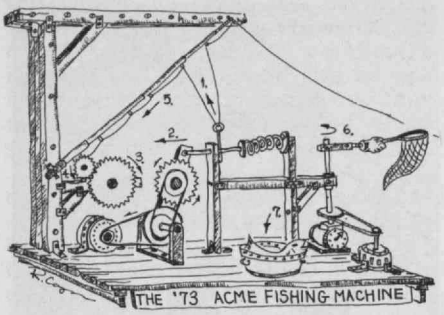
Biologists generally agree that to further exploit marine productivity will require a technology not unlike that of modern agriculture. To do this, one at the very least would have to limit predation, control diseases and interspecies competition, and perhaps exercise some control over the growing environment. Obviously, none of this is likely to occur soon in the open ocean.

On or near land, rudimentary fish farming is not new. A Chinese scholar wrote the first treatise on the subject in 475 B.C. At about the same time, juvenile shrimp were captured in the Far East on tidal exchanges and "pastured" in lagoons. The Japanese now raise these crustaceans from the egg to market.

Even these somewhat elementary methods can enlarge yields enormously. In Asia, carp sometimes are stocked and cultivated. Large-scale feeding, under otherwise comparable conditions, multiplies more than 5,000-fold the fresh-weight yield of the same fish.

These numbers can become prodigious when compared with terrestrial output. A ton or more of fish or 100 tons of shellfish can be harvested from the same space that a few hundred pounds of beef cattle would require; a pig farmer needs a man-year to produce 25 tons of live pigs, the same time it takes an oyster grower to raise 40 to 60 tons of oysters, not counting the shells. This is a matter of ecological efficiency, of maximum conversion of solar energy into animal protein.

Thus, the potential appears promising, even with the rather artless state of present-day aquaculture. When fishermen of the Japanese inland sea were beset by diminishing catches, their government developed an industry in culturing a jack, the yellowtail. The men who now grow the yellowtail make more money than they did netting for it. The yellowtail is a high-cost food, in common with shrimp and



"... man at sea ... remains a hunter"

lobster, and it is likely that near-future aquaculture, at least in developed nations, will be dedicated mainly to such profitable products. (It is a maxim, however, that luxury foods no longer are so sumptious when they can be mass-produced cheaply. Remember chicken-every-Sunday?)

Indeed, some of the country's most advanced aquaculture has focused on shrimp. At the Galveston facilities of the National Marine Fisheries Service, 3 million shrimp a month have been raised—born of captured gravid females. Scientists there have been able to bring males, but not females, to sexual maturity.

If this inability has to do with light levels and/or nutrition, as is suspected, a tool is at hand that may provide clues. Later this year, my colleagues at the University of Arizona's Environmental Research Laboratory, working with the Galveston group and with Mexican scientists on the Gulf of California, will begin growing shrimp in greenhouse-like enclosures in which essentially all environmental parameters can be controlled carefully.

Not many of the present experiments in farming the sea are this sophisticated, though. Most can only loosely be described as true aquaculture, assuming that the term is to be likened to agriculture. Almost none of them constitute "marine husbandry." By analogy, a cattle rancher who was unable to prevent predation upon his livestock, to keep poisonous weeds from his pasture or to treat his ailing animals soon would become bankrupt.

Marine Biology Languishing

If animals and plants from the sea are to be husbanded, they must be domesticated. This implies that a particular animal is carefully selected, its needs and preferences determined, and as near-to-optimum conditions as possible provided for its survival. This would necessitate the manipulation of many more factors, and far more elusive ones, including those elemental forces over which conventional fishermen are powerless.

Light levels, for example, bear subtly upon the food web. Probably the most important of the environmental factors, however, are temperature, salinity, oxygen and the fertility and purity of the water.

Inverse relationships exist between temperature and solubility of oxygen, and between salinity and oxygen solubility. When the temperature rises or when salinity increases, the oxygen-holding capacity of the water decreases. Temperature especially affects respiration. A number of aquatic animals, if they are to mate and reproduce, need exceedingly circumscribed environmental conditions. Hence, moderation of water temperature or flow sometimes activates spawning.

The water must be both fertile and pure. Water that is safe for your swimming may be lethal to some marine creatures. If the culture water is clean, the temperature is stable and nutrition is adequate, disease control poses less of a problem.

Only when the microclimate may be managed, more or less at will, will it become possible to breed marine animals specifically for such things as increased growth and food-conversion rates, disease resistance, and confined culture conditions, as has been done on land with plants and animals. Not surprisingly, the marine biologists are far behind.

Except for oyster culture, which has made some progress, there are no invertebrate breeding programs; and genetic control has been obtained with only three aquatic vertebrates: carp, Chinook salmon and several species of trout. Unlike Chinese and Indian carps, the reproduction of the common carp can be regulated; so, it has been possible to develop strains of them that, among other advantages, are more fecund, mature earlier, and are fleshier.

Chinook salmon and rainbow trout stock at the University of Washington have been continuously graded for selection for many years. The trout not only tolerate higher temperatures than their wild congeners, they also grow to almost seven pounds in 18 months—15 times or more what a wild rainbow trout weighs at the same age.

Carle O. Hodge is Research Coordinator of the Environmental Research Laboratory at the University of Arizona.

Technology for World Peace

Kurt Waldheim

The contribution which science and technology has already made to resolving the problems of mankind since 1945 has been immense. The United Nations has been actively involved in all these activities. The "green revolution," the remarkable development of fertilizers, the services of the World Weather Watch and the Global Atmospheric Program of the World Meteorological Organization, the immensely significant new knowledge derived from outer space and sea-bed researches, the advances in medical science and computer technology, the proposed United Nations "earth-watch" environmental program—these are only some of the areas in which advances in science and technology have benefitted mankind as a whole.

On matters concerning outer space, for example, the United Nations plays an important role. It was under United Nations auspices that the international agreement prohibiting the placing of nuclear weapons in outer space was signed in 1967—a treaty of immense importance to mankind. We are also engaged in the dissemination of information about space technology and its relevance to some of the pressing social and economic problems of the developing countries. In these countries, too, communication satellites could be of considerable benefit to remote villages in education and in unification of national cultures. We are also actively exploring the possible role of the United Nations system in disseminating data from satellites surveying earth resources. This has a major potential in agriculture, in map-making for mineral resources and land uses, and in locating available water resources.

We Have, They Have Not: an Ever-Widening Gap

However, despite these and many other efforts of the United Nations over the past two decades to increase scientific and technological knowledge and its application to the needs of all mankind, the fact remains that the gulf between the advanced and the developing countries, far from being reduced, is remorselessly increasing.

How can we close this gulf? What can we do?

The central fact of our time is that over half of the population of the world—principally concentrated in Asia, Africa and Latin America—lives at tragically low levels of existence. The standards which citizens of the United States or Europe take for granted are unknown in these countries.

There is no excuse for anyone to plead ignorance of these facts. They have been reiterated again and again, and they are grimly irrefutable. Furthermore, the decline in foreign aid to these countries means that if they are to advance at all they must to a large extent raise themselves by their own efforts. In this situation, development with the objective of improving the condition of the poor must be the dominant concern of *all* concerned citizens. It is impossible to exaggerate the scale and importance of this subject. When such glaring disparities exist between the rich and the poor countries we are confronted with a situation of profound economic, social, and political instability.

Many people in the advanced countries have, correctly, begun to question the value and relevance of a ruthless pursuit of economic growth at any price; but we must never forget that the only hope of improving the quality of life of the poor nations lies in development. It was for this reason that the member states of the United Nations, during the celebration of the anniversary in 1970, proclaimed the decade of the 1970s as the Second United Nations Development Decade and unanimously adopted the International Development Strategy as a major policy commitment undertaken individually and

collectively on the part of both the developed and the developing countries.

The passing of resolutions and proclamations is one thing; effective action is another.

Technology as a two-Edged Sword

We now realize, much more clearly than we did even five years ago, that the task of reducing the economic imbalances between the developed and developing countries is one of enormous complexity. It would not be too severe a judgment to say that our approach in the past was essentially simplistic. It is indeed sobering to look back upon the plans, programs, and projections for the developing countries over the past two decades and then look at the results. I do not wish to express criticism; indeed, much admirable work has been done. The contribution of the United Nations has been remarkable. But the problems were new, vast, and urgent, and our experience was small. It is now essential that we learn from this initial pioneering experience.

How are the poor countries to improve their conditions? What are their resources and what are their deficiencies?

Usually labor and capital are regarded as the crucial factors for growth; but there is a third—technology. In fact, new inputs of labor and capital accounted for less than half of the increase in production in the advanced countries since World War II; far more was due to technological innovation.

In the developing countries, which have ample labor but little capital, technological advances could be a major factor in the solution of economic problems, provided only that the technology was of a kind to employ labor and reduce capital.

But what is the situation which we face? Almost 98 per cent of the world's scientific and technological resources is concentrated in the advanced countries. Over half of the world's research and development effort is devoted to such specific national and military objectives of the advanced countries as nuclear science, space technology, and defense-related projects. The balance is distributed between goals related to economics, welfare, and increasing general knowledge. Their economic research is usually also geared to the objectives of advanced countries. And much of the nonmilitary work in the advanced countries has as its goal the evolution of technology which will reduce those countries' need for primary products largely imported from the developing countries. Such research not only benefits the advanced countries but actually injures the developing countries.

Here, in blunt terms, we see the scale of the problem we confront.

Combining Existing and New Knowledge

How, then, are we going to obtain the technology for development? Here it is necessary to be cautious. Many of the problems of the developing countries are common to all—or most—of them. But the problems are very rarely identical, and certainly their resolution cannot be identical, because every effective measure must be firmly based upon the particular circumstances of each country.

Development Forum (U.N.)

"... [evolving] technologies appropriate to specific needs ..."

Nonetheless, there are certain general points which are worth attention.

The advanced countries themselves have gone through several phases of growth. We should take a hard look at this experience and relate it to conditions in the developing countries.

This is a highly complex and controversial topic. The whole subject of "intermediate technology" is full of difficulties, and I am certainly not suggesting that the developing countries should be offered second-rate technologies. What I am suggesting is that the experience of the developed countries should be analyzed and put at the disposal of the developing countries.

But there are many other factors. Rather belatedly, we have become aware of the environmental consequences of technology. The United Nations Conference on the Human Environment in June, 1972, emphasized the fact that the developing countries, although understandably mainly interested in development, are anxious not to repeat the errors of the older industrialized nations. The reconciliation of development and environmental priorities is one of the most difficult problems we face, and it must be solved.

But the exploration of existing knowledge, important though this is, is not enough. The developing countries must recognize that they not only must adapt existing knowledge; they also need to evolve new knowledge on which to base technologies appropriate to their specific needs and resources. Accordingly, each developing country will have to create its own organization for development. Because some of the developing countries are very small, they must join to evolve common approaches and institutions for growth. But no nation is too small to have within its frontiers the technical and intellectual capacity to recognize what are its needs and to determine what is relevant to those needs.

What the Developed Countries Can Do

Though the main impetus must lie within the developing countries themselves, the developed countries and the United Nations can and must give important assistance and advice. To achieve this, the

developed countries must undertake a commitment to assist the developing countries in undertaking research and building up the essential technological infrastructure. They should also be willing to devote a percentage of their own research and development effort to the specific problems of developing countries.

There is yet another way in which the developed countries can be of practical assistance. The developing countries are today paying almost $1.5 billion annually for the transfer of technology by way of royalties for patents, consulting services, etc. This is a heavy burden upon their foreign earnings, particularly as most of them also have the problem of servicing their foreign debts. Surely, in an atmosphere of relaxation of political tension, the advanced countries could revive the commitment to human betterment which immediately after the end of World War II produced such positive results. The cost to them would not, in relation to their wealth, be very great, and the benefit to the poor countries would be immense. I cannot believe that this is impossible to achieve.

I am convinced that the climate for applying science and technology to the problems of development is better now than it ever was. Increasingly, scientists are becoming acutely aware of their moral responsibility for the application of the results of their work to the benefit of mankind as a whole. Moreover, the improved atmosphere of international detente should make it possible to free at least some scientific resources for civilian research. There is a great opportunity for taking up the priority problems of the poor nations of the world.

I therefore urge a more human, compassionate, and practical involvement in the well-being of our fellow residents on our planet. We are, in every respect, interdependent. Let us recognize that fact in our actions and not merely in pious aspirations.

This essay is an abridgment of remarks by the Secretary General of the United Nations to members of the M.I.T. Alumni Center of New York at the U.N. Headquarters on March 27, 1973.

Institutions as Corporate Owners

Book Review
Jeptha H. Wade

The Ethical Investor
John G. Simon, Charles W. Powers, and Jon P. Gunneman, New Haven: Yale University Press, 1972. 208 pp. $2.95

I am grateful to the authors for putting this study together, since any of us who have been involved in trying to represent to the larger corporations the position of the larger institutional investors, particularly universities, can use all the help we can get. As a work, it is scholarly, orderly, thoughtful, and thorough, and therefore it is useful to the technician in this field. It is also, I am forced to say, dull, pedantic, lifeless, and mechanistic—logical but somewhat inert except for occasional flashes. The result is not the kind of work that one can recommend to the person with a casual interest in the field.

The book has its origin in a series of meetings undertaken at Yale in 1968 and 1969, followed by a seminar in the 1969-70 academic year. The backbone of the material which presumably resulted from these sources is an appendix entitled "Suggested Guidelines for the Consideration of Factors Other Than Maximum Return in the Management of the University's Investment." That title is deceptive, since one of the basic criteria on which the entire exercise is founded is that "maximum economic return will be the exclusive criteria for selection and retention of the universities endowment securities except in cases . . . relating to the disposition of securities in certain circumstances." Now they've got me doing it.

The plain truth is that these guidelines have a formality and grace matched in common experience only by the Internal Revenue Code, which is not to imply that they provide equivalent precision; but the guidelines are useful nonetheless. This question of institutional responsibility has an eel-like tendency to squirm off in all directions, and I suspect that the rigid-appearing structure of the guidelines and the work in general is an attempt to restrain the subject from flowing indiscriminately. It is at least partially successful, but the success has a price: There is an inevitable lack of sparkle in a text that describes itself as dealing with "socially injurious consequences of income-generating activity."

I can understand the authors' difficulties in making the material palatable which led to putting this backbone in as an appendix. But I suggest that those who read this book because of their interest in this deeply interesting subject start with the appendix.

The guidelines suggest that a university should vote on matters raised in corporation proxies (or otherwise) by favoring propositions which seek to eliminate or reduce social injury caused by a company's activities—unless doing so will either be too expensive for the corporation or too expensive for the university. I am paraphrasing. If I had a basic criticism of this aspect of the book it would be that absolutely no attention is paid anywhere to the problem of how one determines the facts and reaches the conclusion on which one is then asking as large an institution as Yale to act. The problem is particularly difficult because the primary activity of universities in this field in the last few years, and probably in the next few, is in voting proxies. This they must do in fulfilling their moral obligation (I believe) as shareholders, but there is a practical problem for institutions with large and diversified portfolios. Over half of this activity comes in a six-week period running from February 15 through March, and this is a very short space of time for all the study and discussion that should be conducted.

The theory of corporate management, as Milton Freidman delights in emphasizing, is that a corporation's entire purpose in life is carried out if it maximizes profit. This theory is so deeply engrained that every possible humanely-oriented instinct of a manager must somehow be rationalized on the basis that in the long term (unproveable) future his responsible behavior will be justified by the greater profitability of the firm resulting from its better public image, happier employees, or whatever. But the plain truth is that a great many of the decisions which are most difficult for industrial management today fall in that limbo between those which clearly are justified on the basis of producing the greatest profit and the limit which is established by law defining illegal behavior. Within this wide range different managers can reach many different decisions, involving behavior which is more or less profitable and more or less socially responsible. A now-historic example is the authority of directors and managements—now well established—to make donations of a certain part of the owners' profits to non-profit institutions or other charitable good works.

Replacing the Responsible Owner

My own hope—somewhat naive, perhaps—is that institutional shareholders can provide, as a substitute for the old family owner, a justification and, in fact, an enthusiastic endorsement of management behavior which is not forced by law and yet is not clearly within the presently accepted target of maximum profit.

Indeed, I am puzzled and somewhat disappointed by the sense of separation

between the corporation and its owners which runs as a thread through the first section of this work. It seems to me that the professionalism of management to which the authors refer creates the best possible reason, given our theory of stock ownership, for the institutional investor—including the university—to begin to play a responsible role as the owner in lieu of the rapidly vanishing individual owner or family of owners which heretofore acted as true owners, in the sense that a professional hired management cannot act.

Of course, no corporation, as a practical matter, is going to go to its shareholders and say, "We want to behave in this manner even though its going to cost you some money." They may, however, go to their shareholders and say, "We wish to follow these procedures because they are right, though neither you nor we know whether this will be the most profitable procedure." This is, in fact, a realistic position, and some troubled managements may eventually determine that it is a useful position to assume. At present, however, support for this kind of thinking is coming largely from activist groups in relationships which are something other than sympathetic with management. Universities, by and large, would like to appear sympathetic.

Universities' Risks and Responsibilities

Here in a nutshell is the universities' dilemma. Many extremely able, single-minded and dedicated managers of corporations with exceptionally good records seem to be, if not blind to, at least disinterested in the social consequences of some of the corporation's actions. This lack of sensitivity may well become most apparent in the corporation's response to proxy petitions from what are viewed as "wild-eyed radicals." It is in exactly these kinds of situations where a university is least likely to be sympathetic to a corporation's apparently harsh position and the university's action most likely to result in long-term animosities and resentments in the corporate world. The result is to risk adverse effects on the university.

The most poignant of these is likely to be in the field of fund raising, an aspect of the problem but little discussed, except by indirection, in *The Ethical Investor*. I think there is only one fair assumption on which an institutional investor can proceed, particularly one which may have been given securities by persons close to a corporation. The donor must expect the institution to behave with its best judgment in the same way that the individual would have used his best judgment had he been the owner. If this is done in a measured and rational way, then the risk that management will be offended simply is one of many risks in a complex world. I think it is a less serious risk than to behave otherwise, either with respect to potential donors or with respect to the somewhat stilted concept which the authors of *The Ethical Investor* designate "the academic context"—shorthand for the politics of faculty and student bodies.

Of course, as I believe Eli Goldston stated in a review of this work, the first thing that a sensible university administration ought to do if it sees that an investment in a particular company is going to be a political hot potato on its campus is to buy one of the other 2,000-odd securities on the New York Stock Exchange or the thousands available elsewhere which will not create problems that are disruptive to the university's daily functioning. This is a bit of common sense which even the activitists, if they care for the welfare of the university, must admit and which can be followed as long as it does not unreasonably inhibit the university's ability to best manage its investments.

A note on M.I.T.'s procedures as an investor may be of interest. The Corporation has recognized that on these touchy social issues which involve the "conscience" of the university, it would be arrogant for the M.I.T. Corporation itself to vote without listening to a broader range of opinion—indeed, to all of us who comprise M.I.T. (Though I hasten to add that the breadth of the Corporation's view may exceed that for which it is generally given credit by some of the students and faculty.) Accordingly, a Committee on Corporate Responsibility of faculty, students, staff, and alumni has been appointed to consider these aspects of M.I.T.'s investments and to advise the Executive Committee which has the legal responsibility for casting votes. This is the procedure which, in one form or another, is recommended by the authors of *The Ethical Investor* and is presently being followed by a number of major universities in the country. The conclusion in my mind is that the staff, administration, students, and faculty have in this Committee a demonstrated vehicle with which to express their views on matters they believe important in a manner which will be listened to, and—if last year's example is typical—generally followed by the Executive Committee.

Total democracy with everybody participating in every decision is, I hope, on the decline. But there is still a place and a need for a broader spectrum of opinion on decisions which used to be very narrowly focused in a small number of people. Though its original creation was for no more than a two-year period as an experiment, I believe that our Committee on Corporate Responsibility, or something like it, should be a continuing part of the M.I.T. scene.

Jeptha H. Wade, who studied at M.I.T. with the Class of 1945, is a member of the Boston law firm of Choate, Hall and Stewart and of the M.I.T. Corporation and its Committee on Corporate Responsibility.

Art: The Pursuit of Technology

Book Review:
Robert O. Preusser

Science and Technology in Art Today
by Jonathan Benthall
Praeger Publishers, Inc., New York, 1972, 180 pp., illus., $8.95

Plastics for Artists and Craftsmen
by Harry B. Hollander
Watson-Guptill Publications, New York, 1972, 224 pp., illus., $14.95

The pursuit of advanced technological media is an irreversible trend in the evolution of art. It is a development which forecasts drastic alterations in the anatomy, structure and scale of visual form. The need to synthesize a wider spectrum of knowledge and skills than heretofore has been identified with art is apparent. Scientists and engineers, no less than artists, are challenged to explore new modes of performance. Joining artistic sensibilities with technical competence is prerequisite to meeting this challenge.

These books merit attention by the scientific community. Both authors have entered the arena of art with professional backgrounds in engineering. One performing as critic, the other as practitioner, they dispel the myth that scientific training precludes ability to become involved with theory and practice of art.

The media discussed in their books are frequently employed by M.I.T. students, and the examples of their visual experiments accompanying this review further verify that the scientifically oriented can perform creatively in a discipline formerly considered alien; art experience can indeed be integral with technical training. By extending the physical and applied sciences into the realm of visual expression, this educational adventure has proven that art is no longer an exclusive domain of liberal arts colleges.

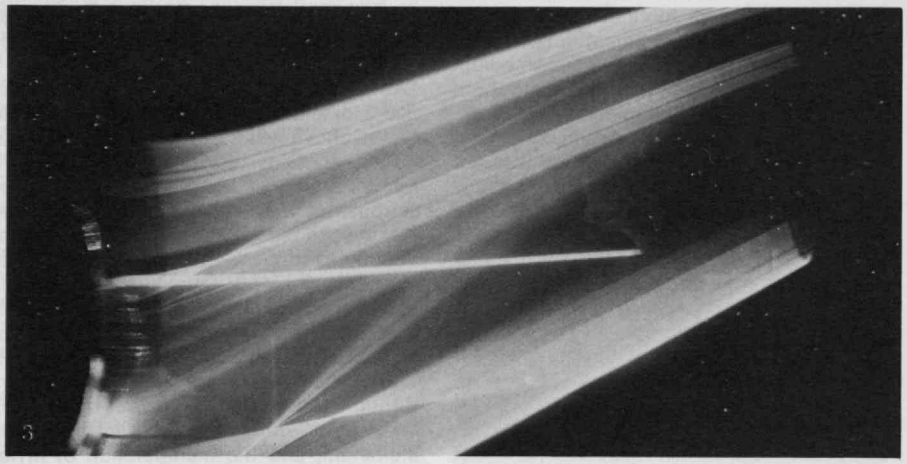
Jonathan Benthall (formally an investment analyst and systems engineer) writes about the current status and future of "art and technology." Harry Hollander (an industrial chemist) instructs "artists and craftsmen" in applying the medium of his specialization.

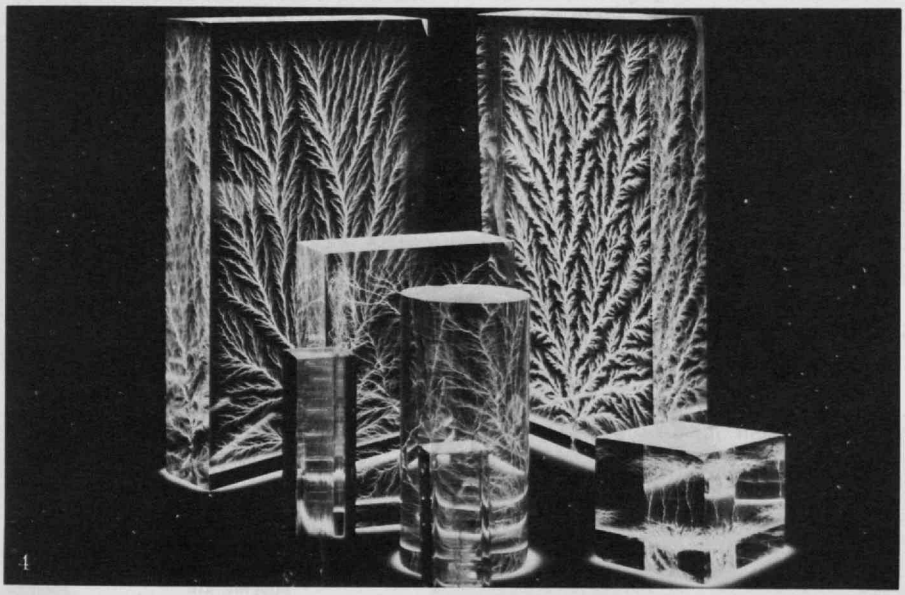
Of the two, Benthall's text is broader in scope. He discusses a range of media with special attention given photography, the computer, and laser holography. The latter, he believes, will prove no less important in evolving a "new aesthetic" than it is in providing a "visual model of modern physics." He predicts that this medium will affect the future of art more profoundly than any other, even though it has been explored by relatively few artists.

The most engaging aspect of this book, however, has to do with the evolving idioms of expression and the author's insights into their successes and failures. His comments on cultural implications of the technological media used by well-known artists are of special interest.

A number of people associated with M.I.T. have contributed to the development of his thesis. Noam Chomsky's formulations are acknowledged as basic in using the science of linguistics to understand art and culture. The techniques of Harold Edgerton and Gjon Mili are sighted in advocating photography as a prototype for the study of how media influence "modes of perception" (a Marshall McLuhan dictum). In analyz-

The author of this review has for many years taught studio courses for undergraduates majoring in all fields of science, engineering, and the social sciences at M.I.T. The illustrations are of student work for these classes, emphasizing art forms which take advantage of materials and techniques from the students' major fields. (Photos: Nishan Bichajian)





1
Fractured polyester casting resin with color injected into crevices, by Terry Brim, '76 (architecture).
2
Crystal growth from sodium acetate in water, by David Richardson, '67 (chemistry).
3
Laser beam projected through lenses into clouded water, by William Parker, '73 (architecture).
4
Lucite penetrated with electron beams from a Van de Graaff high-voltage generator, by Seth Schneidman, '73 (humanities).
5
Shape transformations by reflection in a parabolic plane of mylar, by Scott Fulton, '75 (physics).

ing the computer as a "communications medium", artistic implications are perceived in Nicholas Negroponte's SEEK and Joe Weizenbaum's DOCTOR.

Artists who have been Fellows at Gyorgy Kepes' Center for Advanced Visual Studies are also featured—John Whitney for his pioneering efforts in computer generated films, Alan Sonfist for his use of natural processes to dramatize the relevance of ecology to art, the history of automata as surveyed by Jack Burnham, the use of physical forces by Takis and Otto Piene (now Professor of Environmental Art in the M.I.T. Department of Architecture), and the "cybernetic sculpture" techniques of Tsai.

Whereas Benthall is concerned with conceptualizations and perceptions derived from the new-found alliance of art with science and technology, Harry B. Hollander relates technical information about an industrially developed medium to the fine and applied arts. Twenty-three projects serve to demonstrate how polyester and epoxy resins, silicones and polyurethanes can be used. Each project is described in detail and further clarified with photographs of step-by-step procedures.

These illustrations and accompanying terminology make clear how different are the knowledge and skills necessary to work with plastics as compared with conventional media. Nor can one help but be struck by the alchemy-like characteristics of plastic compounds and the range of visual qualities that result from chemically converting liquids into solids. But some of the examples of finished products by "noted artists and craftsmen" are less than successful in revealing these qualities. There is a tendency to use plastics merely as a substitute for conventional materials.

Students in my visual design course, who have been exploring non-traditional media for a number of years, have found that the greatest visual rewards come from exploiting unique characteristics inherent in materials and in processes for their manipulation. When working with plastics, for example, students do most interesting things when they deviate from established procedures. One such experiment takes advantage of the fracturing that occurs when using more catalyst than is prescribed is used in casting polyester resin. A more sophisticated technique has been the use of a Van de Graaff high-voltage generator to produce dielectric breakdown patterns in Lucite.

As these examples suggest, those who use Hollander's book would do well to be inventive with the technical information it contains. Deviations from certain formulas for forming plastics can be disastrous, of course, but procedures that make possible the unpredictable are frequently worth the gamble. Other visual experiments with scientific phenomena and technological resources by our M.I.T. students have included the growth of crystals with sodium acetate, light patterns created by projecting a laser beam through lenses into clouded water, colored lights reflected in machine-tooled aluminum, and the manipulation of mylar to effect shape transformations. This experience confirms that knowledge and skills fundamental to science and engineering can have artistic implications.

Perhaps more important, however, this approach is exemplary of what Benthall means in his concluding chapter when he refers to art as a "mode of inquiry" not unlike that of science. Noting the increasingly "open-ended" nature of experimentation as it is occurring in both disciplines, he foresees a closer relationship between them.

Benthall observes that art is becoming less object-oriented and science more concerned with changing aspects of reality than determining final truths, and on this basis he predicts an eventual synthesis of art and science. If this prognosis is correct, we can assume that a pedagogy will evolve with less distinction made between scientific and aesthetic understanding than now exists in the learning process.

An Institute Informant

The Editors' digest of recent and current concerns at the Massachusetts Institute of Technology

The Sherman Fairchild Building

M.I.T.'s largest department—electrical engineering—and its oldest interdepartmental laboratory—electronics—are moving this spring into its largest new building since 1916: the Sherman Fairchild Building, named in honor of the founder of Fairchild Camera and Instrument Corp. and Fairchild Industries. In addition to $4 million from the Fairchild Foundation, Inc., the $17.5 million building has been built with funds from 216 individuals, 44 corporations, and five foundations—including Sloan and Kresge. Facilities grants of $1.8 million came from the U.S. Office of Education and the National Institutes of Health; and members of the Department faculty themselves raised or contributed over $2.5 million.

A formal dedication is planned for October 6, 1973.

Phase 3: "I Told You So!"

Lester D. Thurow, Professor of Management and of Economics at M.I.T. who was one of George McGovern's principal economic advisers, says he is "reasonably optimistic" about the economy under phase 3 of President Nixon's stabilization program.

Partly this is because John T. Dunlop, who is Director of the Cost of Living Council on leave from his post as Harvard Dean of Arts and Sciences, is "a very competent guy," Professor Thurow told Barbara Rabinovitz of the *Boston Herald American* this winter. And it is partly because there are at least "surface similarities" between Nixon's phase 3 program and the wage-price stabilization proposal set forth by McGovern during the campaign. "There are a lot of things about which McGovern can say 'I told you so,' and this is certainly one of them."

Experiments in Education . . .

A new Division for Study and Research in Education will begin operations at M.I.T. next fall, focussing in particular—at first, at least—on "the underlying metaphor of 'learner as model builder'." By this it means, says D.S.R.E.'s Steering Committee, something quite like Piaget's aim of characterizing "styles of theory-building in children of various ages."

D.S.R.E. will teach courses in the relations of heuristic programming and artificial intelligence to learning, the relation of genetics to the formulation of early attitudes and methods of thinking, innovation in professional education, and related topics. Its research will focus on the nature of the learning process and the effects of the environment in which it occurs. And its "Greenhouse" will, it hopes, be the setting for testing "innovative educational projects" which come to it from throughout M.I.T.

. . . and in Transportation

Paul O. Roberts, Professor of Civil Engineering, is Director of a new Center for Transportation Studies in which will be focussed the many transportation research projects underway at M.I.T. Seeking to view transportation "as a coordinated whole," Professor Roberts' principal interests, he says, are in intermodal problems.

But social and political factors are also important, and the new Center's assignment can be put very simply: "Innovation and coordination are the keys to getting people and things more quickly and efficiently."

Broken Windows

More than an acre of plywood is now on the outside of the new Hancock Tower in Boston, replacing glass which has been blown—or cracked—out of the facade of the $95-million, 800-ft. skyscraper.

Robert J. Hansen, Professor of Civil Engineering at M.I.T., has been handed the job—through the consulting firm of Hansen, Holley and Biggs—of finding out what has gone wrong. So far the effort involves 30 wind pressure sensors and eight miles of wiring on the outside of the building and a series of model tests now being carried out in M.I.T.'s Wright Brothers Wind Tunnel *(see photo).*

With the building already far behind schedule, Professor Hansen is under heavy pressure to find a reason—and a solution. Until he does, his comments are guarded and his relations with the press at best reluctant. As in most complex problems, he thinks, no single effect is likely to emerge as the cause, or a single correction the cure.

Selling Women Down the River?

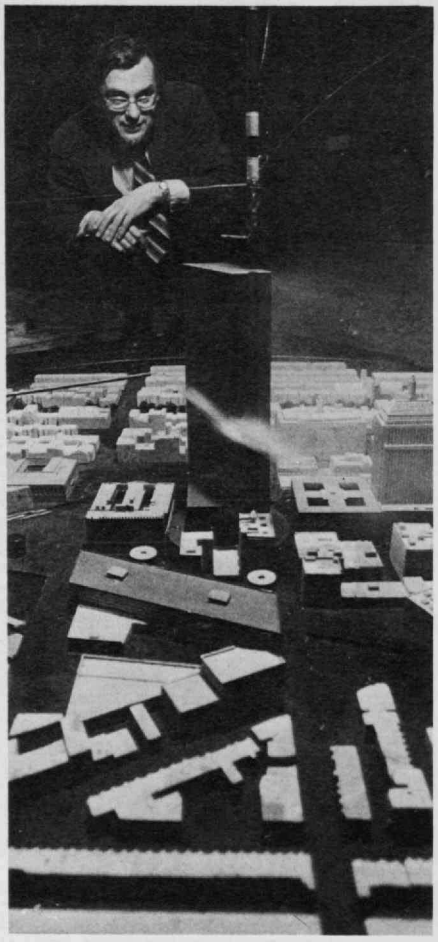
M.I.T. and Wellesley will continue their cross-registration programs for their undergraduates, but a housing shortage in Cambridge caused the Institute to cancel a residence exchange. Debate on the question was more lively than many expected, for it served to dramatize "a series of unsolved problems in the experience of women at M.I.T. which clearly require close attention," in the words of the joint M.I.T.-Wellesley committee.

The problem, said Emily L. Wick, Professor of Food Chemistry who is in some sense a champion of women at M.I.T.: "We so very often, inadvertently to be sure, sell our women students down the river by acting as though they don't exist. We don't do this intentionally," she told her faculty colleagues during the Wellesley-M.I.T. program debate. "Quite the opposite; the goodness of our intentions only makes matters worse and the state of being ignored is, therefore, all the more complete and bitter . . ."

Meanwhile, Paul E. Gray, Chancellor of the Institute, told M.I.T.'s women alumnae that the Institute is committed to doing all it can to correct the nation's "persistent underutilization of women" and the equally persistent image of M.I.T. "as a place where students carry slide rules in their belts and Stilson wrenches in their pockets." He thinks that 15 per cent of the freshmen who enter M.I.T. next fall will be women, and 35 women (vs. 17 in 1970) are now members of the Institute faculty.

In Memoriam . . .

Spring found M.I.T. mourning the sudden deaths of two distinguished members of its faculty: Donald G. Marquis, Sarnoff Professor in the Sloan School of Management who was an authority on the ad-



Frank H. Durgin is supervising wind tunnel tests made at M.I.T. for Hansen, Holley and Biggs, a consulting firm whose Robert J. Hansen (Professor of Civil Engineering at the Institute) is seeking the cause of glass failures in the facade of the 800-ft. Hancock Building nearing completion in Boston. The effort also includes strain gage tests and foundation studies; no answer yet from Professor Hansen after some four months on the job. (Photo: Margo Foote)

Technology Review's

Classified Section

PUBLICATIONS

TOMORROW'S WORLD . . . a semi-monthly newsletter for those interested in the late 1970's, 1980's and beyond. 24 issues per year; annual subscription rate, $75. For sample copy, write: Hilltop House, Barrett's Hill Rd., R.F.D. 2, Hudson, New Hampshire 03051.

THE YANKEE GUIDE to the New England Countryside. Indispensable for Spring/Summer New England vacationers. On your newsstand now or send $2 to Yankee, Box TR, Dublin, New Hampshire 03444.

TECHNOLOGY TRANSFER: How To Make It Work. 96pp., $7 ppd. See review in *IEEE Spectrum*, Oct., '72, p.110. Olken Pubs. 2830 Kennedy St., Livermore, CA 94550.

RENTALS

U.S. VIRG. ISLS. St. John Nat'l Park luxury cottage, hilltop, fabulous views $100-$150/wk. Spring/Summer 617-255-3376.

WANTED

CAMERA CATALOGS before 1950 wanted. Lester Hehn, Port Washington, NY 11050.

WANTED—Antique figure skates, any make, size, etc. What have you? Will haggle. Write: Don Severance '38, 29 Hampshire Rd., Wellesley Hills, Mass. 02181.

ANNOUNCEMENTS

MIT YEARBOOKS: We have a limited number of MIT yearbooks over and above our archive editions from the classes of 1887 to 1973. If you are interested in obtaining one (or more) of these, write: Susan Burk, M.I.T. Branch Post Office 5, Cambridge, Mass. 02139. A $5 donation is requested.

TECHNOLOGY ASSESSMENT & TRANSFER Advanced Study Institute in Technology Transfer, Novotel Paris-Every, June 24-July 6: lectures and discussion of latest methodology and implementation of technology transfer. Further information: Marvin J. Cetron, Forecasting International Ltd., 1500 Wilson Blvd., Arlington, Va 22209. (703) 527-1311.

FOR SALE

MINIATURE RR. Amer. 4-4-0 steamer, gas diesel, cars, 7½" track, $4750. J. Johnston, 4 Hillside, Rehoboth, MA

IMMEDIATE DELIVERY

PDP 8 series—HP 2116 C
PDP 15/20—Nova 4000
SEL 810 A—DDP 516
also
Tape Drives, Disks, CR, CP
IBM 735 I/O Selectric
ASR 33, 35, 37 KSR 33, 35, 37

"Sonny" Monosson, '48 Bill Grinker, '56
CALL: 617/261-1100
Send for FREE Price List

American Used Computer Corp.
15 School St., Boston, MA 02108

THIS SPACE FOR SALE

Classified Ads: $2.80 per line; two-line minimum. (Allow 35 letters & spaces for first line; 40 letters & spaces for each additional line.) **Display Ads:** $25.00 for first column inch; $20.00 for each additional inch. Frequency rates available. **Copy Deadline:** one month prior to publication date. Payment in advance of insertion required for less than three insertions in one year. Send orders to: Classified Section, *Technology Review*, M.I.T., E19-429, Cambridge, Mass. 02139.

ministration of research and development, and Edwin R. Gilliland, Professor of Chemical Engineering, who is credited with the key research in the catalytic cracking of petroleum.

The Mudd Building
A gift of $1.775 million from the Seeley G. Mudd Fund has completed financing for the Institute's new Center for Cancer Research—the bulk of whose support will come from the National Cancer Institute. The Center's building at 40 Ames Street in Cambridge will be named for Dr. Mudd.

The Bassoonist Is a Physicist
The M.I.T. Symphony Orchestra—96 students and other members of the Institute's Cambridge community—is back from the most ambitious concert tour in its history. Audiences (nearly 10,000 in five cities—Philadelphia, Dallas, San Francisco, Los Angeles, and Chicago) and critics alike were generous. Marilyn Tucker of the *San Francisco Chronicle* found the Orchestra "on a par with the best" but found "disconcerting . . . the number of violinists, say, who are listed as potential electrical and mechanical engineers or that the principal bassoonist is a physics graduate."

$345,000 in Lieu of Taxes
Though M.I.T. reiterated its "determination to maintain its lawful tax exemption," the Institute in 1972 paid the city of Cambridge a total of $345,000 as a contribution in lieu of taxes. The Institute also paid Cambridge some $1.8 million on taxable property owned by M.I.T.; its total tax and in-lieu-of-tax payments to Cambridge during the past five years have totalled over $8.9 million.

Arrivals and Departures
Walter S. Owen, Vice President for Science and Research at Northwestern University, will join M.I.T. as Head of the Department of Metallurgy and Materials Science on July 1. . . . Charles S. Draper, who as Professor of Aeronautics and Astronautics organized M.I.T.'s Instrumentation Laboratory for research on guidance and control systems, will retire as Director of the Laboratory on June 30; he'll be succeeded by Robert A. Duffy, Vice President of the Laboratory—which was renamed in 1970 to honor its founder. The Laboratory will be divested from M.I.T.'s management in July, 1973, and Dr. Draper will continue as a member of its Board of Directors and as a consultant.

Institute Review

Announced and Opened: The Big New Fairchild Building

What everyone on the campus has been watching for two years or more is now official:

The largest building to be added to M.I.T.'s educational plant since the Institute came to Cambridge is being completed this spring for the Department of Electrical Engineering and Research Laboratory of Electronics.

There was no groundbreaking and no official news—until March 2, when Howard W. Johnson, Chairman of the Corporation, announced at a luncheon following a meeting of the Corporation that the Fairchild Foundation, Inc., had made a $4 million grant to complete funding of the building—which would accordingly be named the Sherman Fairchild Building in memory of the Foundation's founder.

Really two connected structures, one six and one eight stories high, the Fairchild Building contains 230,000 ft.^{2} of space for classrooms, laboratories, offices, instrument rooms, and mechanical and electronic shops. Its total cost is $17.5 million, and Mr. Johnson said many donors—in addition to the Fairchild Foundation, Inc.—had contributed funds to make it possible. Among them he listed the Sloan and Kresge Foundations, 216 individuals, and 44 corporations; in addition there were facilities grants totalling $1.8 million from the U.S. Office of Education and the National Institutes of Health.

Members of the Department's faculty themselves raised or contributed over $2.5 million for the building, Mr. Johnson said.

Electrical engineering is M.I.T.'s largest department, with 1,200 students and nearly 100 faculty; and R.L.E. is its largest interdepartmental laboratory, drawing research workers from 11 different academic departments. Some of R.L.E.'s work is still done in "temporary" buildings built for its predecessor, the Radiation Laboratory, during World War II, and Mr. Johnson was right when he said at the Corporation luncheon that "everyone at M.I.T. will be affected" by the move of these activities into the Fairchild Building this spring.

A dedication is planned for October 6, 1973.

Sherman Fairchild, who died on March 28, 1971, was founder and Chairman of the Board of Fairchild Camera and Instrument Corp. and Fairchild Industries. Mr. Johnson described him as "a man deeply committed to science and its ramifications in industry, whose life work closely paralleled the work to be housed in the new facilities." President Jerome B. Wiesner agreed, saying in the official statement that "I can recall no person we have memorialized at the Institute whose life and professional accomplishments have more closely paralleled the activities to be housed in a particular named building. The whole sweep of M.I.T.'s work in electrical engineering and electronics," said Dr. Wiesner, "reflects Mr. Fairchild's contributions to industry, research and education."

Mr. Fairchild first achieved fame for inventions which made possible accurate aerial photography, and he is credited with doing more than any other person in history to map the earth's surface accurately. This interest led him to build aircraft in which to fly cameras—the Fairchild Engine and Airplane Corp. (now Fairchild Industries), which has built more than 40,000 aircraft of all types. He was a founder of Pan American Airlines, a Director of International Business Machines Corp. for 44 years, and associated with founding or operating many other companies manufacturing aircraft equipment, sound recording instruments, film projection systems, and electronic components and systems.

D.S.R.E.: How to Learn, and Other Experiments in Education

Hoping to "encourage new programs and methods of instruction," the Commission on M.I.T. Education (1969-71) urged development at M.I.T. of a center which could foster educational experiments and research.

That proposal, since metamorphosed into an Education Division, is about to become a reality. Responding to a progress report from the Education Division Steering Committee, President Jerome B. Wiesner announced this spring that he will "take those steps required to establish a Division for Study and Research in Education as an operating unit of the Institute," beginning in 1973-74.

If the Steering Committee's proposals are realized, the new Division—which its planners think of as parallel to the Division of Health Sciences and Tech-

The Sherman Fairchild Building for the Department of Electrical Engineering and the Research Laboratory of Electronics has been a campus landmark long before its construction was officially announced early this spring. Designed by Skidmore, Owings and Merrill of Chicago, the building was built by the Vappi Construction Co.—whose success at completing it on schedule and within estimate was cited by Howard W. Johnson, Chairman of the Corporation, when he reported in March that occupants would begin to move into the new laboratories and offices even before the end of spring.

nology within the structure of M.I.T.—would make "an orthogonal cut across vertically parallel departments and schools, with some of the characteristics of a department and some of an interdisciplinary research laboratory."

It would make a slow start in its first years, experimenting with various programs and activities but focussing on what the Steering Committee calls "the underlying metaphor of 'learner as model builder'." Here is how that is described in a progress report from the Steering Committee to President Wiesner this spring:

"The metaphor of 'learner as model builder' makes the fundamental hypothesis that the learner can be an active intellectual agent, constantly reformulating his knowledge, fitting it together in different ways, and essentially constructing theories about the way the subject is structured, the best way to proceed in order to learn, the best way to 'get by' in classroom situations, etc. Of the several major types of research into education and learning, Piaget perhaps comes closest to our focus when he investigates the theories children make to explain natural phenomena such as the winds (e.g., 'the trees do it by waving their branches'). His arm is to characterize styles of theory-building in children of various ages. He talks, for example, about kinds of theories and degrees of originality, asking whether the child turns up only theories he has heard before or whether he constructs them himself. There are a variety of such approaches which seem promising and which could add considerably to our understanding of the learning process and could guide our attempts to change it."

Here are three such approaches the Steering Committee has chosen for early emphasis:

☐ How children build models of the subjects they are learning and of themselves as learners. A better understanding at this level, thinks the Steering Committee, might lead to reformulations of the learning and teaching process at higher levels, too.

☐ How people build models of themselves, of their relationships with other people, and of the things expected of them in educational encounters. This is clearly related to the spirit in which students at every level respond to classes, laboratory work, or educational programs of other kinds.

☐ How people learn new forms of behavior—how, for an example pertinent to science and engineering education, they form their conception of the professional. "Studying the learning of new forms of behavior is complimentary to studying the way students learn to be problem-solvers," thinks the Steering Committee.

D.S.R.E.: Classes and "The Greenhouse"

Its Steering Committee pledges the new Division to both teaching and research.

Teaching, it is proposed, will take the form of several courses in each term of 1973-74; the titles and subjects include foundations of education, the relationship of heuristic programming and artificial intelligence to learning, natural structures of thought in children, professional education, innovation in higher education, and educational media.

D.S.R.E.'s research interests will be of two kinds: fundamental studies of the learning process and the effects of the environment in which it takes place, and work on M.I.T. teaching activities centered in what its Steering Committee calls "the Greenhouse," which it hopes will be a reservoir of expertise in education and thus "a nurturing setting for innovative projects, . . . an opportunity (for many at M.I.T.) to participate in educational innovation." The idea is that new teaching devices and plans might be brought to "the Greenhouse" by faculty from throughout the Institute, who could here find help in developing them.

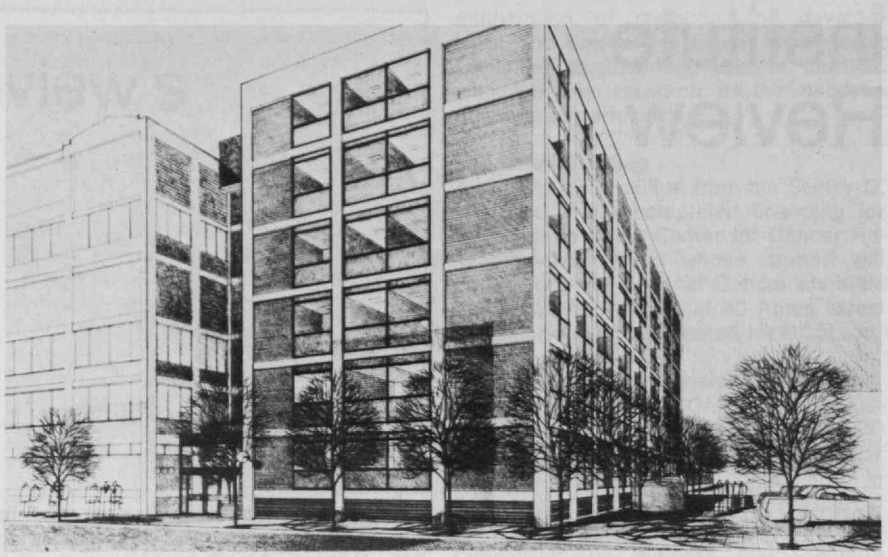
The same research enterprises would also help a few Ph.D. students in Institute departments gain some experience in education research. And eventually, thinks the Steering Committee, the D.S.R.E. is likely to propose a doctoral program for students who are interested in combining work in a professional field at M.I.T. with work in education—theory or practice.

In short, says the Steering Committee, the tasks of D.S.R.E. will be two-fold:

☐ To conduct research in education.

☐ To train "a new cadre of researchers equipped with unique combinations of competencies" needed for "insightful research in education." And in the process, D.S.R.E. should foster "an environment where those studying educational processes and those involved in trying new educational processes for M.I.T. can . . . share both problems and insights."

The Steering Committee was chaired by William T. Martin, Professor of Mathematics; transmitting the report to the faculty, President Wiesner said he found the plans "both highly innovative and provocative."



This is how the Seeley G. Mudd Building, housing M.I.T.'s new Center for Cancer Research, will look by the end of 1974. A $1.775 million grant from the Seeley G. Mudd Fund, added to $3.15 million awarded to M.I.T. early this year by the National Cancer Institute, will make possible what Dr. Salvador E. Luria, Director of the Center, believes will be "a suitable environment . . . for some of the most distinguished cancer researchers in the country . . . to carry out studies from which a cure for cancer may ultimately emerge." Plans for the "complete reconstruction" of the building, now devoted to light industry, have been drawn by Marvin E. Goody and John M. Clancy and Associates, Inc., Boston.

$1.775 Million for the Mudd Building for Cancer Research

When the job of turning a candy factory into a modern biological laboratory is finished, it will be the Seeley G. Mudd Building at 40 Ames Street in Cambridge.

Its tenant will be M.I.T.'s new Center for Cancer Research.

Dr. Seeley G. Mudd's name is to be attached to the building as a result of a $1.775 million grant from the Seeley G. Mudd Fund, to supplement the $3.15 million awarded to M.I.T. early this year by the National Cancer Institute (*see* Technology Review *for February, p. 73*).

Dr. Salvador E. Luria, Director of the Center, greeted the Mudd Fund's announcement with predictable enthusiasm: the gift "will greatly accelerate the start of our long research program into the causes of cancer" and enable M.I.T. "to complete excellent facilities . . . from which a cure for cancer may ultimately emerge."

Dr. Mudd was both physician and engineer by training, and President Jerome B. Wiesner says the Mudd Fund gift has "remarkable relevance . . . for the large and increasing number of our students who are setting out on careers in medicine." Dr. Mudd's career began at Columbia University (B.S. in engineering, 1917) and brought him to Harvard Medical School (M.D. summa cum laude, 1924) and Massachusetts General Hospital. He entered private practice in cardiology in California, then in 1934 joined the faculty at California Institute of Technology as Professor of Radiation Therapy. He died in 1968, having become Dean of the University of Southern California Medical School in 1941.

During his lifetime Dr. Mudd contributed more than $10 million to colleges and universities, and he established the Fund

which bears his name under his will to continue benefactions to higher education. It was his brother, Harvey S. Mudd, whose name was chosen for Harvey Mudd College, Pomona, Calif., in 1955.

Can M.I.T. Aspire to Teach Black Science and Technology?

You teach at M.I.T. You live in Belmont, drive your air-conditioned car to Cambridge in the morning and back to Belmont in the evening. You fly to Washington, and to New York; and you stay at the Statler, and the Commodore, and do your business in the marbled halls of the National Science Foundation and on the smooth, deep carpets of the Carnegie Corporation. What can the black student in your class who came to M.I.T. from distant Georgia know—or care—about your life and values?

You're an M.I.T. graduate, black, working for a living at Bell Laboratories, or Aerospace Corp., or Princeton. You've little affection for M.I.T., remembering mostly a hassle with the administration, uneasiness with fellow-students, frustrations in the classrooms. But what can you know about today's black student, and his vision of black science and technology?

The answer to all these questions is likely to be the same: Very little.

Just as there is a generation gap between fathers and sons in the white world today, so there is one in the black world—no part of which yet belongs in the white world, either. A discomforting conclusion from the Black Student Union's student-alumni Conference on Black Science and Technology at M.I.T. on April 7.

Black science is a very special part of science, explained Darryl Dawson, '73, the Conference Co-chairman: that part of science that can be used to alleviate problems of black people. The black student's chief problem at M.I.T. today, said Mr. Dawson, is to keep his work pointed toward the solution of problems in black science.

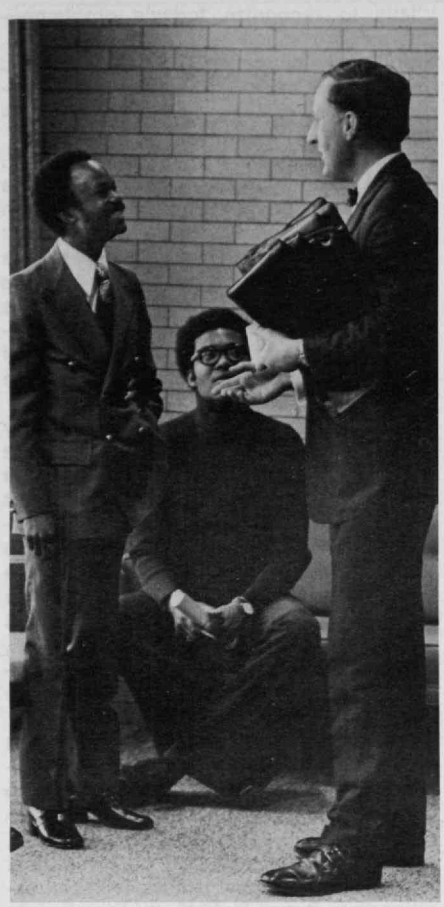
There are other problems, too, explained other students who sought to tell 20 or more alumni what it's like to be black at M.I.T. today: "I've never really felt at home at M.I.T.," said Gregory G. Johnson, '73; "What if you got asked for an I.D. card ten times a week?"

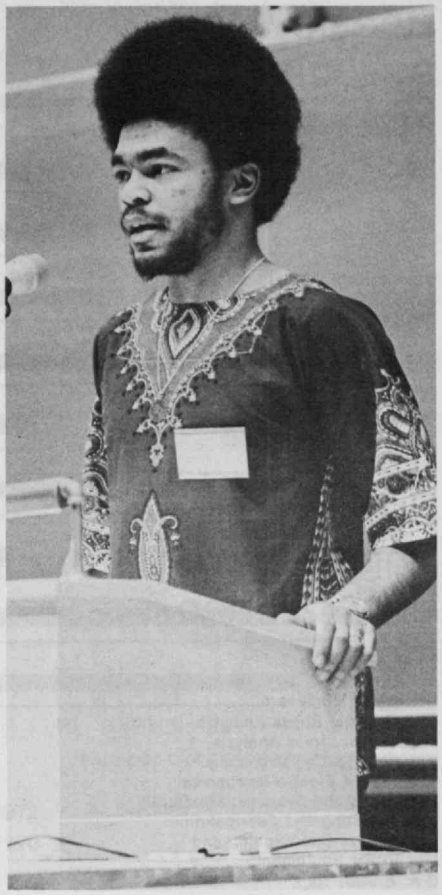
"No one should have to endure a hostile environment while getting an education," thinks Michael E. Fant, '73—but that's what he finds in Cambridge. "There's nothing for the black students here except themselves."

"Why didn't you get your yearbook picture taken?" asked his mother. Because, Mr. Fant explained to the conference, "the experiences I can remember going through here aren't the ones that will be in *Technique*." So, he said, my job at M.I.T. is simply to "be sure the training I get here will do good for blacks—not for whites."

Mr. Fant's advice to President Wiesner: "Try to make this place more accommodating to black students, not black students more accommodating to M.I.T."

Charles A. Cofield, a graduate student in architecture and planning: the faculty





Black alumni and students came together in April for a conference unique in M.I.T's history. Darryl Dawson, '73, the meeting Co-Chairman (top right), said his goal as a student is to learn all he can about black science and technology; and Gary W. Oliver, '74, sounded more militant: "I'm going to get everything I can out of this school, and I'm going to let them know what I feel!" Alumni—including Robert P. Pinckney, '52 (above, with President Jerome B. Wiesner)—had bitter-sweet memories of the Institute, too. (Photos: Sheldon Lowenthal, '74)

"fails to recognize today's problems—there's too much emphasis on classic, traditional education." What's needed most is the "faculty to assess what we—as blacks—really want to get from school."

Lyman J. Alexander, '73, came to M.I.T. full of hope that the Institute could be above the "bigotry and hatred" which he knew at home. He's disappointed: there "is no couseling help for people like me, who have no confidence in white counseling;" there are few blacks on the faculty, so "M.I.T. is turning black students into fake white students. . . . I'll probably never come back to Boston because of M.I.T."

Being a black woman in society today is hard enough, but it's harder still to be a coed, and black, at M.I.T., thinks Portia Smith, '73. Some professors start their classes by saying, "Good morning, *gentlemen.*" Some of them give their whole lectures looking at you, to make sure you understand—as if everyone else would if you did. Then there's the social hassle: if you tell a man you go to M.I.T., he says, "I'm sorry, you're too heavy!"—and that's the end of that. "If I had it to do again, I wouldn't come!"

Victor L. Ransom, '48, who is now at Bell Telephone Laboratories, Inc., remembers how it was: he left M.I.T. with no strong feelings of attachment, never returned until 20 years after he graduated, when Bell Labs sent him out recruiting. Now he thinks the Institute is more exciting than it was in 1948. "If there's ever going to be a fair number of blacks in a company like Bell Labs," said Mr. Ransom, "it will be because students like you who keep coming to us make us think about black science."

Charles A. Whitney, '51, recalling undergraduate days for his black student audience: "I think you have it rougher than we did. There were only four or five of us—an elite, treated well enough. We weren't confronting the race problem as you are . . ."

Finally Walter A. Rosenblith, Provost, was at once disturbed and reassured—reassured because both students and alumni proved to him that they needed—and were using—their M.I.T. opportunities; disturbed, because the conference gave him "a very different view of the responsibilities of M.I.T." Now, said Professor Rosenblith, he begins to understand why more blacks is not enough; there must be at M.I.T. "a kind of critical mass on blacks' common problems."

Minority Students: Special Problems, Special Help

"If I had it to do again, I wouldn't come!"

No one at the Conference on Black Science and Technology at M.IT. this spring (*see above*) could miss the sting in Portia Smith's words, or doubt her sense of hurt. And no one could escape the question:

If black students' views of science and engineering are so unlike M.I.T.'s white traditions, and their response to its community life so hostile, can the Institute aspire to a significant role in minority education?

The same question took a different form in the spring of 1972 for Paul E. Gray, '54, Chancellor, who is Chairman of the Institute's Task Force on Educational Opportunity. Though M.I.T.'s enrollment of blacks had increased steadily since 1968, when the Institute first sought to admit disadvantaged students under criteria which took into account their special problems and needs, Dr. Gray concluded that 'the progress measured in enrollment figures does not tell the full story." At least three difficulties had become apparent:

☐ The number of black applicants for undergraduate study had peaked in 1970 and decreased thereafter; special recruitment efforts had not led to further expansion of the applicant pool, Dr. Gray found.

☐ The academic performance of black undergraduates was "somewhat short of initial expectations."

☐ The Institute had been less successful than it wished in increasing the number of blacks on the faculty between 1969 and 1972.

After three years of experience with the effort to make M.I.T. educational programs available to "significant numbers" of minority students, thought Dr. Gray, the problems and successes of that effort should be appraised and the effort itself perhaps redirected.

So it was that a year ago he and President Jerome B. Wiesner asked Albert G. Hill, Vice President—Research, to chair a Commission on Minority Education which would make whatever suggestions it could on how M.I.T. might better fulfill its "continuing commitment to expand educational opportunity for black and other minority-group students."

Now, after a year of studying M.I.T.'s problems and the experiences of many other institutions with programs of similar goals, Professor Hill and his Commission have reported: The problem is easily enough defined, but a solution is at best elusive.

The problem is simple but "profound," thinks the Commission: "The effect on the black student of coming into a community in which he sees very little that resembles his previous environment and little that projects new image models." Some students adjust and succeed, but too many do not.

M.I.T.'s approach in the past has been to offer disadvantaged minority students a special summer of classes and other activities before they start their freshman year—and then to let them make their way simply as all other freshmen do. Some special structures were provided—help for a Black Student Union tutorial program, minority representatives in many administrative offices, a growing number of minorities on staff and faculty—but in general the effectiveness of the programs depended upon black students' initiative and ability to compete for administrators' and advisers' attention in a world that the blacks themselves found largely foreign.

M.I.T.'s three-year experience proves that blacks do have special problems, says Dr. Hill's Commission, and they cannot simply be melded into the white student population. "There are, in fact, 'two' Institutes—one as perceived by whites

and another that minority students see."

Blacks now understand this, too. In 1969 blacks wanted to be "just like everyone else" at M.I.T. Now they want to have the special services they need, to have the goals they perceive for themselves recognized as different from those of others at M.I.T., "to identify themselves in order to help themselves."

Accordingly, says Dr. Hill's Commission, M.I.T. should establish, as a four-year experiment, an Office of Minority Education to serve as an explicit "advocate" for minority students. Its job would be "to coordinate, improve, and create services and programs" for minority students—anything it thinks "likely to increase minority student survival at the Institute."

O.M.E.'s reach will have to be long; what is needed, thinks the Commission, is "a comprehensive approach that tries at best to understand, and at least to recognize, all the forces and influences—academic, social, personal—impinging upon a student. . . . It is now clear that faculty, administration, housing, fellow students, and cultural ethos are critically important in enabling a student to respond successfully to an educational institution and its curriculum."

O.M.E. would begin with a single Director, who should have the role of Assistant to the Chancellor for Minority Education; in time there should be one to three more staff assistants.

Affirmative Action: Because "It Is Right and Proper"

Can public spirit, pious statements, and good intentions assure a growing role for minorities as students, teachers, and employees in colleges and universities?

Congress and the White House think not, and in a series of bills and Executive Orders since 1968 all federal contractors—including universities—have been asked to increase the participation of women, blacks, American Indians, and other minorities in all their activities. Those which did not comply could not receive federal funds. The task of enforcement in the case of universities was given to the Department of Health, Education and Welfare.

An affirmative action plan for M.I.T. is now before H.E.W. for approval; it calls for effort on seven fronts:

- ☐ Fairer representation of women and minorities in all job categories.
- ☐ More career development efforts.
- ☐ Equal pay for equal work.
- ☐ Special educational benefits for employees.
- ☐ More women and minority students in both undergraduate and graduate courses.
- ☐ No discrimination against women and minority applicants.
- ☐ Maximum procurement of products and services from minority and female vendors.

More Than a Moral Commitment

A long, intensive, and sometimes confusing effort stands behind M.I.T.'s current affirmative action plan. The Institute first submitted a program for improving employment opportunities for women and minorities in October, 1969. More than two years later H.E.W. replied: M.I.T.'s original affirmative action program was "not workable;" the university could and should do more to positively press departments and offices to search for and if necessary train women and minority workers for whatever openings they have.

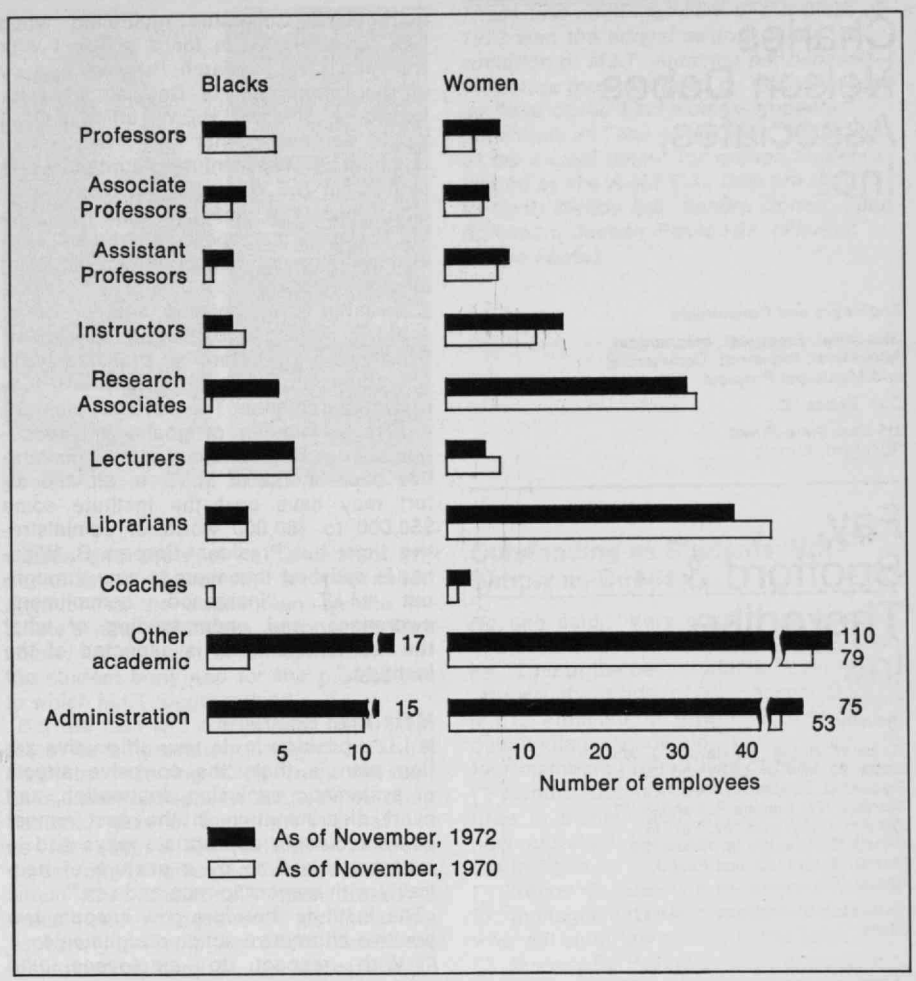
"The high priority and sincere commitment to (affirmative action) must be stated more definitely than just an endorsement of ideals or moral commitment," said H.E.W.'s criticism.

But H.E.W. did not find the Institute in noncompliance with federal regulations, and therefore made no suggestion of suspending or cancelling federal grants and contracts. Indeed, M.I.T. seemed to be considered by H.E.W. a "model" of affirmative action in the Boston area; the Institute was said, for example, to have more contracts with minority vendors than any other Greater Boston university.

Taken aback by H.E.W.'s criticisms, M.I.T. nonetheless reluctantly admitted in March, 1972, that it might do better. Dr. Benson Snyder, who was then Dean for Institute Relations and Chairman of the Institute's Equal Opportunity Committee, said H.E.W.'s "general criticism is right and we know it. . . . The simple fact is that M.I.T. does not yet have enough women and enough blacks and other minorities employed at all levels of the university."

Work on a new affirmative action plan began immediately, the responsibility centered chiefly in the hands of James C. Allison, Assistant to the President and Chancellor for Minority Affairs.

Before it was finished, there was a second surprise: On March 27, 1973, M.I.T. was told that a new Air Force research contract (with the Draper Laboratory) would not come on April 1 because H.E.W. could not certify that M.I.T. was in compliance with affirmative action re-



More than two years after M.I.T. adopted its first affirmative action plan in October, 1969, Dr. Benson R. Snyder, Dean for Institute Relations and Chairman of the M.I.T. Equal Opportunity Committee, admitted to the Department of Health, Education and Welfare that "the basic problem (of underemployment of blacks and women) still exists. . . . The simple fact is that M.I.T. does not yet have enough women and enough blacks and other minorities employed at all levels of the university." A revised program, with specific targets based on the concept of utilization—minorities should be represented at the Institute in the proportion they are represented in the total of workers in the Boston area in each job category—has now been adopted at the Institute. The chart above shows the numbers of blacks and of women in the M.I.T. faculty, academic staff, and administration (not including the special laboratories and the Division of Sponsored Research) in November, 1970, and May, 1972.

quirements. Confusion multiplied when one day later funds for a contract with the Advanced Research Projects Agency of the Department of Defense were released; a different H.E.W. office said it would not certify that M.I.T. was not in compliance. The confusion turned out to stem from H.E.W.'s effort to obtain specific plans from many colleges who, like M.I.T., found the report requirement hard to meet because it dealt with an old issue in a very new way.

The latter view prevailed, and as of May 1 M.I.T., having submitted a revised affirmative action plan, is presumably in full compliance with all appropriate federal requirements. The revised plan includes statements of goals and procedures from 86 academic and administrative departments at M.I.T. In all, the effort may have cost the Institute some $50,000 to $60,000 worth of administrative time, but President Jerome B. Wiesner is satisfied that there is now throughout M.I.T. "increased commitment, awareness, and understanding of what the law is and what is expected of the Institute."

More Than Neutrality

M.I.T.'s position in its new affirmative action plan is that "the corrosive effects of systematic exclusion, inattention, and overt discrimination in the past cannot be remedied in appropriate ways and in a reasonable time by a posture of neutrality with respect to race and sex."

The Institute therefore now accepts two positive affirmative action assignments:

☐ With respect to employees, "to achieve a representation of women and minorities that is at least in proportion to their current availability;" and to provide "new opportunities for career development."

☐ With respect to students, "to achieve representations of minorities and women in the student body which reflect their current availability and interests, and to encourage large proportions of these groups to seek careers for which the Institute's educational resources are designed to prepare them."

In both cases, says the new affirmative action plan, M.I.T.'s commitment "transcends legal or contractual requirements;" the Institute undertakes the plan not because it is required to, but because it is "right and proper" that it do so.

Employees: the Concept of Utilization

The key to M.I.T.'s new affirmative action goals for employees is the concept of "utilization:" minorities should be represented among any particular group of M.I.T. employees—faculty, technicians, secretaries, service workers, managers—in at least the proportion they are reasonably available for recruitment.

For example, data from the Massachusetts Commission Against Discrimination and United Community Services show that in Boston 10 per cent of office and clerical workers are blacks, 2 per cent are Spanish; in Cambridge 7.1 per cent are blacks, 1.7 per cent are Spanish. The goal of each group at M.I.T., then, is to have at least comparable percentages of its own office clerical staff from those two minority groups by July, 1975, or sooner if possible. In the Institute's affirmative action plan, each department has recorded its present (May, 1973) situation, its interim target for July, 1974, and a plan for how it will reach the goal in 1975.

Since faculty and students are presumably recruited on a national basis, the percentage of qualified minority group members in the U.S. is the appropriate base for M.I.T.

Such specific goals and timetables are the essential new feature of the new affirmative action plan. But the goals in the current plan are not to be considered final, for new goals will be considered in future plans to further improve M.I.T.'s utilization of minorities wherever possible, says President Jerome B. Wiesner, to enlarge the opportunities for minorities through training, promotion, and "plain over-utilization" if necessary.

Each department also pledges to conduct salary-equity reviews and to correct inequities revealed; each will maintain statistics on its performance in relation to minority employment; and each has designated a representative to be responsible for these programs.

Without exception, in every employment category from faculty to custodian and every department and laboratory, M.I.T.'s affirmative action goals "reflect over time an increase in the utilization of minority and female personnel," says Paul E. Gray, '54, Chancellor, to whom has fallen the task of coordinating M.I.T. efforts and reporting them to H.E.W.

Already there has been some progress, thinks Dr. Gray—a 1 per cent gain in minority employment and a 2 per cent gain in female employment at M.I.T. since 1971; included in these figures are increases from eight to 11 blacks and from 17 to 35 women on the M.I.T. faculty. And of the Institute's "bi-weekly" employees—the category in which most office/clerical workers fall—more than 7 per cent are blacks and 2 per cent Spanish, up from 5 per cent and 1 per cent, respectively, in November, 1970.

Students: "Changing the Mood and Culture"

To bring more women and minority members to M.I.T. as students, the Institute will seek to find more qualified applicants and to remove whatever "educational, social, and financial barriers which have discouraged many women and minority students" in the past.

Already M.I.T.'s enrollment of minority and women students has increased sharply in a decade. In its affirmative action report the Institute pledges to continue the efforts which have made possible this increase, admitting that such students remain "underrepresented in most student categories at M.I.T." In addition to present efforts to reach potential minority students, to help them succeed at the Institute when they have arrived, and to assure them a full experience in campus activites, the Institute proposes that "social clubs and fraternities" will in the future "submit written nondiscrimination pledges." The affirmative action plan also pledges that women will be encouraged "to participate fully in athletic activities of their choice."

These four coed members of the Class of 1973 won the annual awards of the Association of M.I.T. Alumnae not because they were recommended by their teachers as "one of the best women students," but simply as "one of the best." Honored at the annual dinner for women students hosted by the A.M.I.T.A., they are (left to right) Wendy Erb, Sandra Cohen, Ellen Spielman, Jeanne Paskowitz. (Photos: Margo Foote)

Renewed interest in the effects of counseling and the academic environment on minority students is indicated in a report from a Commission on Minority Education (*see below*), but M.I.T.'s affirmative action plan stops short of promising the Office of Minority Education which that Commission proposed.

At a press conference following release of the new affirmative action plan, President Wiesner expressed his special interest in methods of increasing the number of blacks who come to M.I.T.—a "nontrivial intellectual task," he thinks. He is not concerned about the cost of whatever efforts M.I.T. commits to finding more blacks, or even more women; but he is aware that adding minority and women students may well affect the balance of students among the Institute's schools. This carries with it a "larger financial problem" and perhaps as well "a question of changing the mood and the culture" of M.I.T.

The Chancellor's Goals: More Women, the Same "Eccentricity"

M.I.T. "has never marched to the common wisdom of what an educational institution should be like. Nor will it in the future," says Paul E. Gray, '54, Chancellor.

Taking "what about tomorrow?" (the theme of the current ABC-TV series in which M.I.T. has been a principal participant) as his text, Dr. Gray listed four future tasks for the Institute when he spoke early this spring to the annual student-alumni dinner of the Association of M.I.T. Alumnae:

☐ To adapt itself to current needs—continuing excellence in science and engineering while working, too, for better understanding of the interface between technology and the principal societal problems to which its know-how may be applied.

☐ To provide more flexible curricula so that the Institute can respond to the wider range of student interests.

☐ To "maintain our eccentricity," that uncommon education which has been traditional at M.I.T. since its founding.

☐ To expand its service to women and minorities.

Dr. Gray spoke especially of the nation's nascent understanding of the causes and costs of its "persistent underutilization of women," and he called attention to the commitment in the Institute's new affirmative action plan *(see above)* for actively recruiting women—for the student body and for the professions to which M.I.T. degrees lead.

But the task will not be easy, he thinks: there is a "persistent image" of M.I.T. students "carrying slide rules in their belts and Stilson wrenches in their pockets." Part of the effort will have to be far beyond M.I.T. itself—"to build career opportunities for women in fields which have traditionally been closed to them," and changes such as these are especially difficult, he thinks, when the Institute and many of the professions to which it is devoted are in a "no-growth" mode.

But a beginning has been made. The number of women on the M.I.T. faculty has doubled in two years (from 17 in 1970 to 35 now), and 15 per cent of next fall's freshmen—more than ever before—are likely to be women, he thinks.

Are You Coming? Can We Help You?

At an earlier briefing, Peter H. Richardson, '48, Director of Admissions, had outlined some of the ways women were being encouraged to consider and come to the Institute; it proved to have been a month-by-month campaign during the critical months of the fall.

☐ In September, Mr. Richardson wrote all women who completed the College Entrance Examination Board mathematics test with scores of 800 or more: Have you considered M.I.T.?

☐ In October, he wrote to over 2,000 women who were semifinalists in the National Merit Scholarships: same suggestion.

☐ In November every woman whose application for admission remained incomplete had a letter from an M.I.T. coed.

The result was 10 per cent more applications from women for the Class of 1977 than a year earlier, for the Class of 1976.

And in April, after the decisions had been made, every woman who had been admitted to the Institute received a telephone call from an M.I.T. coed: Are you coming? Have you any questions? Can we help you decide?

Outstanding as Students, Not Simply as Coeds

No one said, "Very good for a woman." The recommendations were simple—such as, "One of the best students I ever had."

Hence the pride of the Association of M.I.T. Alumnae in giving its awards for outstanding academic performance to four members of the Class of 1973:

☐ Sandra Cohen, who received her degree in management in February and is now Assistant Director of Admissions at the Institute.

☐ Wendy E. Erb, whose degree will be in management and mathematics and who will enter law school in the fall.

☐ Jeanne B. Paskowitz, an engineering major who will continue with graduate study in computer sciences.

☐ Ellen A. Spielman, who hopes to enter medical school after receiving her M.I.T. degree in chemistry and life sciences.

Promotions: 22 New Professors, 33 New Associate Professors

Twenty-two members of the M.I.T. faculty have been promoted to the rank of full professor, effective July 1; and 33 members of the faculty and staff have been named associate professors, effective on the same date.

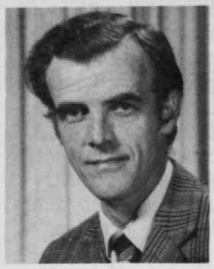
The new professors are:

☐ John P. Appleton, Department of Mechanical Engineering—at M.I.T. since 1967, holds the doctorate (1961) from Southampton University.

☐ Michael Athans, Department of Electrical Engineering—at the Institute since 1964 after studies (B.S. 1958, M.S. 1959, and Ph.D. 1961) at the University of California.

☐ Donald L. M. Blackmer, Department of Political Science—former Assistant Director of the Center for International Studies; now Executive Officer of the Department of Political Science. Graduate of Harvard (A.B. 1952, A.M. 1956, Ph.D. 1967), at M.I.T. since 1961.

☐ James D. Bruce, Sc.D.'64, Department of Electrical Engineering—Master of Burton-Conner House and Associate Dean of the School of Engineering; came to M.I.T. for graduate study from Lamar State College of Technology in 1958, joined the teaching staff in 1964.



J. P. Appleton

M. Athans

D. L. M. Blackmer

J. D. Bruce

M. Dertouzos

J. Deutch

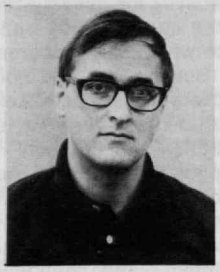
A. W. Drake

L. B. Evans

V. W. Guillemin

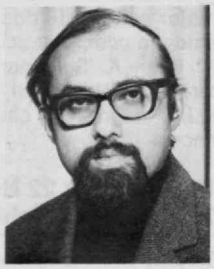
N. D. Ham

D. S. Kemp



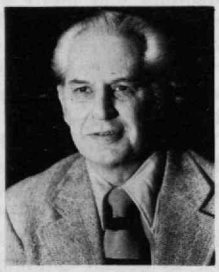
R. P. Kiparsky

W. A. Litle



S. K. Mitter

F. E. Perkins



R. O. Preusser

J. R. Ross

N. Sivin

B. Spacks

R. Weiss

G. Wolf

S. Yip

☐ Michael Dertouzos, Ph.D.'64, Department of Electrical Engineering—a member of the teaching staff since 1964; came to M.I.T. for graduate study following work at the University of Arkansas (B.S. 1957, M.S. 1959).

☐ John M. Deutch, '61, Department of Chemistry—studied at Amherst College (B.A. 1961) and M.I.T. (Ph.D. 1965), on the M.I.T. teaching staff since 1969.

☐ Alvin W. Drake, '58, Department of Electrical Engineering—Associate Director of the M.I.T. Operations Research Center; has taught at M.I.T. since 1962, after undergraduate and graduate (S.M. 1958, E.E. 1959) study.

☐ Lawrence B. Evans, Department of Chemical Engineering—Executive Officer of the Department of Chemical Engineering; academic work at the Universities of Oklahoma (B.S. 1956) and of Michigan (M.S.E. 1957, Ph.D. 1962); teaching at M.I.T. since then.

☐ Victor W. Guillemin, Department of Mathematics—Harvard (B.A. 1959, Ph.D. 1962) and Chicago (M.A. 1960) graduate, first came to M.I.T. in 1966.

☐ Norman D. Ham, Sc.D.'68, Department of Aeronautics and Astronautics—on the M.I.T. teaching staff since 1962, holds undergraduate degree from the University of Toronto and graduate degrees (S.M. 1952, Aero.E. 1957) from M.I.T.

☐ Daniel S. Kemp, Department of Chemistry—studied at Reed College (A.B. 1958) and Harvard (Ph.D. 1964), at M.I.T. since then.

☐ R. Paul Kiparsky, Ph.D.'65, Department of Foreign Literatures and Linguistics—on the M.I.T. faculty since 1965, following undergraduate study at the University of Helsinki and graduate work at the University of Minnesota (M.S. 1963) and M.I.T.

☐ William A. Litle, Department of Civil Engineering—graduated from University of Santa Clara and Stanford, teaching at M.I.T. since 1963.

☐ Sanjoy K. Mitter, Department of Electrical Engineering—came to M.I.T. as Visiting Associate Professor in 1970 following study at the University of London (Ph.D. 1965 from Imperial College).

☐ Frank E. Perkins, '55, Department of Civil Engineering—joined the teaching staff in 1965 after undergraduate and graduate (S.M. 1959, Sc.D. 1966) work at M.I.T.

☐ Robert O. Preusser, Department of Architecture—graduate of the Institute of Design (Chicago) and the Art Center School of Los Angeles, has taught visual design at M.I.T. since 1957.

☐ John R. Ross, Ph.D.'51, Department of Foreign Literatures and Linguistics—undergraduate work at Queen's College (B.A. 1948), teaching at M.I.T. since 1966.

☐ Nathan Sivin, '58, Department of Humanities—advanced work at Harvard (M.A. 1960, Ph.D. 1966), has taught history at M.I.T. since then.

☐ Barry Spacks, Department of Humanities—noted as novelist and poet, studied at the Universities of Pennsylvania (B.A. 1959) and Indiana (M.A. 1956), has taught literature at M.I.T. since 1969.

☐ Rainer Weiss, '55, Department of Physics—a member of the teaching staff since completing graduate work at M.I.T. (Ph.D. 1964).

☐ George Wolf, Department of Nutrition and Food Science—studied at the Universities of London (B.A. 1944) and Oxford (D.Phil. 1947), at M.I.T. since 1962.
☐ Sidney Yip, Department of Nuclear Engineering—at M.I.T. since 1965, completed academic work at the University of Michigan (Ph.D. 1962).

Associate Professors
Faculty and staff named as Associate professors include:
☐ Arthur B. Baggeroer, Department of Electrical Engineering
☐ Ulrich J. Becker, Department of Physics
☐ Carl M. Bender, Department of Mathematics
☐ Ronald A. Blanken, Department of Nuclear Engineering
☐ George S. Boolos, Ph.D.'66, Department of Philosophy
☐ David Botstein, Department of Biology
☐ Louis B. D. Braida, Ph.D.'69, Department of Electrical Engineering
☐ Boruch A. Brody, Department of Philosophy
☐ Wit Busza, Department of Physics
☐ Clark K. Colton, Ph.D.'69, Department of Chemical Engineering
☐ Huw G. Davies, Department of Mechanical Engineering
☐ Michael S. Feld, '63, Department of Physics
☐ John C. Graves, Department of Philosophy
☐ Jonathan W. Green, Department of Architecture (photography)
☐ Roger E. Kaufman, Department of Mechanical Engineering
☐ Ralph L. Keeney, Ph.D.'69, Sloan School of Management (operations research)
☐ Jin-Au Kong, Department of Electrical Engineering
☐ Robert C. Merton, Ph.D.'70, Sloan School of Management (finance)
☐ Richard S. Naylor, '61, Department of Earth and Planetary Sciences (geology)
☐ David A. Oliver, Department of Aeronautics and Astronautics
☐ Richard M. Price, Department of Physics
☐ Saul A. Rappaport, Ph.D.'68, Department of Physics
☐ Ronald C. Shank, '59, Department of Nutrition and Food Science (food toxicology)
☐ K. Barry Sharpless, Department of Chemistry
☐ Arthur P. Solomon (associate Director of the Harvard-M.I.T. Joint Center for Urban Studies), Department of Urban Studies and Planning
☐ John B. Southard, '60, Department of Earth and Planetary Sciences (geology)
☐ Jacques N. Sultan, Ph.D.'69, Department of Civil Engineering
☐ Erik H. Vanmarcke, Ph.D.'70, Department of Civil Engineering
☐ Roy E. Welsch, Sloan School of Management (operations research)
☐ Richard W. Wertz, Department of Humanities (history)
☐ Nigel H. M. Wilson, Ph.D.'70, Department of Civil Engineering
☐ Patrick H. Winston, '65, Department of Electrical Engineering
☐ Ian T. Young, '66, Department of Electrical Engineering

"It Smiles As It Plays . . . A Happy Orchestra" with 10,000 Fans

The audiences and the critics—almost without exception—liked the music. But even more they liked the musicians: the idea that a technological institute famous for its scientists and engineers could field an orchestra "on a par with the best."

Indeed, Marilyn Tucker, reviewing the M.I.T. Symphony Orchestra's concert in the War Memorial Opera House for the *San Francisco Chronicle,* described her situation as "disconcerting, . . . considering the number of violinists, say, who are listed as potential electrical and mechanical engineers or that the principal bassoonist is a physics graduate."

In 10 days between March 23 and April 1 the Orchestra, on the most ambitious concert tour in its history, played to audiences totalling nearly 10,000 in five principal American cities—Philadelphia, Dallas, San Francisco, Los Angeles, and Chicago. In addition to parents and friends, Orchestra members met several thousand alumni at receptions arranged by alumni committees in each city.

It was a heady experience, calculated to raise everyone's spirits and improve everyone's view of the arts at M.I.T.— the latter being a principal purpose of the trip's sponsorship by the newly-formed Council on the Arts at M.I.T.

The Orchestra's program, chosen by Professor David M. Epstein, its Conductor, was the same in each city: *Two Nocturnes* by Debussey, *Metamorphoses* by Barry L. Vercoe (he is Assistant Professor of Music at M.I.T.), the Mozart *Concerto in E Flat for Two Pianos* (the soloists were John Buttrick, Professor of Music, and Robert S. Freeman, Associate Professor of Music), and Brahms' *Symphony No. 2.*

Ever-Growing Enthusiasm
Without exception the Orchestra won enthusiastic applause from its audiences, and the group's musical competence was acclaimed by every music critic but one. The exception was Charles Shere in the *Oakland Tribune,* who said (of the same concert reviewed by Miss Tucker—see above) that "even by nonprofessional standards the orchestra did not play very well. . . . poor intonation, timid playing, wrong entrances, misadjusted balances . . ." An off-night for Mr. Shere, think those who travelled with the Orchestra, for the program seemed in fact to be increasingly interesting and challenging as the tour progressed, performed with ever-greater enthusiasm.

Several aspects of the tour—those perhaps most important to the student musicians—were less obvious: the sense of excitement at performing before large audiences in great halls; the unscheduled performances in hotel rooms, airport lounges, a park in Dallas, even a street corner in San Francisco; a chance to hear Seiji Ozawa rehearsing the San Francisco Symphony.

Spontaneity and Joy
The concert settings varied enormously. Philadelphia's Academy of Music is a very elaborate hall, decorated with red

"... a University in Which Music Is Flourishing ..."

The following review of the M.I.T. Symphony Orchestra's performance in Orchestra Hall, Chicago, on April 1, was written by Robert C. Marsh for the Chicago Sun-Times, *from which it is repeated by permission.*

Harvard men traditionally called it "Tech," just as Oxford humanists traditionally referred to the sciences as "stinks." Both names leave a lot untold.

In fact, Massachusetts Institute of Technology in Cambridge, universally known as M.I.T., is now a university in the fullest sense of the word. Moreover it is a university in which music is flourishing in a manner many traditional liberal-arts colleges might envy.

That became clear Sunday night when the M.I.T. Symphony Orhcestra, David Epstein, Conductor, visited Orchestra Hall as the final stop on a 10-day national tour that included Philadelphia, Dallas, Los Angeles, and San Francisco.

An Ensemble of the Highest Level

Talking to Epstein, a lot of things become clearer. He is an alumnus of a select group of young American conductors who, over the years, worked as apprentices with George Szell and the Cleveland Orchestra.

But he also is a composer and, very clearly, a dedicated teacher and orchestra builder. He directed the Sunday concert with the quiet confidence and authority one would expect from a Szell student. Even allowing for the cumulative effect of playing the same tour program several times in a row, the orchestra was wonderfully responsive to him and proved itself to be a student ensemble of the very highest level.

M.I.T. has a fine orchestra, in part, because it willingly broke down the Chinese walls that can separate educational institutions in the same community and formed an alliance with Wellesley College that provides talented young women musicians at Wellesley with an opportunity to play in a high-quality orchestral group—something Wellesley could not do by itself.

It is a happy orchestra. It smiles as it plays. It takes obvious pleasure when a difficult passage goes well. And it brings to its music the sense of spontaneity and joy, the simple satisfaction in encountering the beautiful, that professional musicians so often lose, despite their dedication and skill. When did you last see a cellist in the Chicago Symphony with a flower tied to the scroll of the instrument?

Some Quite Extraordinary Playing

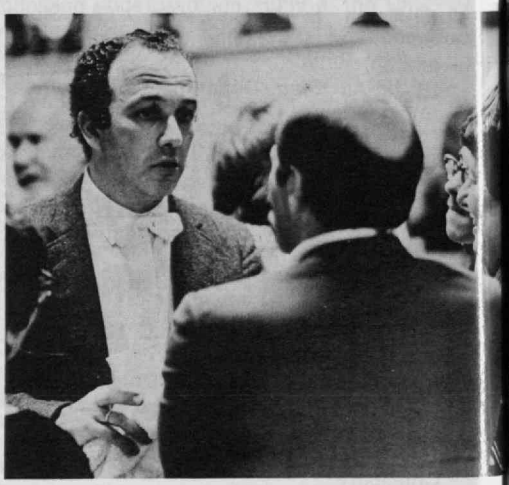
Epstein chose a program that contrasted four different musical styles, and in its length and difficulty would be a worthy test for any orchestra of reputation. He achieved it with an over-all high level of success.

The most difficult work on the program was the Mozart Concerto in E Flat for Two Pianos, K. 365, with two M.I.T. faculty members, John Buttrick and Robert Freeman, as soloists. In Mozart, everything shows. The style must be consistent and right, and playing must have the proper degree of lightness, energy and grace.

This performance was somewhat short of the mark, a little heavy and not quite as elegant as one might wish, although still a very good job.

But there was some quite extraordinary playing in the two Debussy Nocturnes ("Clouds" and "Festivals"), with lovely gradations in tone; clear, open textures, and some very sensitive ensemble work. Any conservatory orchestra would have been proud of that performance, or the vigorous statement of the Second Brahms symphony with which Epstein brought the evening to a close.

The fourth item on the program was an example of composition at M.I.T., "Metamorphoses" by Barry Vercoe, a neo-Webern-like score of five short movements with real lyric interest, a genuine sense of drama and effective scoring which provided these young players with another opportunity to show us their best.



Most of these pictures need no description; they record the music, sightseeing, fun, and even exhaustion which made the M.I.T. Symphony Orchestra's spring national tour a success for all concerned. Alumni were hospitable everywhere—above top, the exotic residence of Edward O. Vetter, '42, in Dallas, Texas, and, center, Mrs. Leonard Mautner (her husband is Class of 1939) with Professor Roy Lamson in Los Angeles. So were audiences—opposite, top left, in Chicago's Orchestra Hall and, top right, in the War Memorial Auditorium in San Francisco. (Photos: Andrew C. Goldstein, '71, Margery Goldstein, and Sheldon Lowenthal, '74)

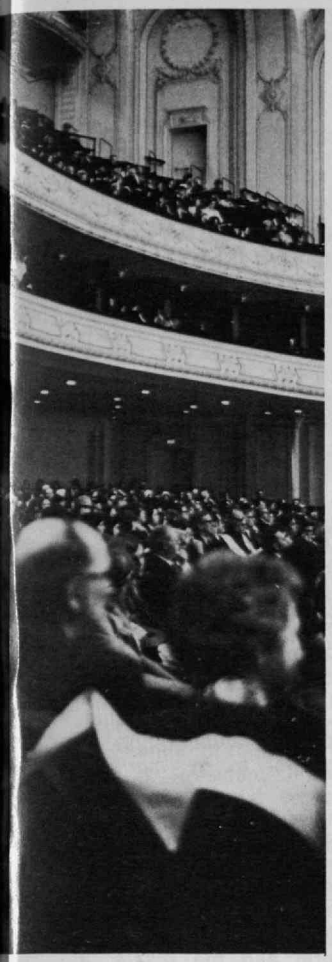
velvet chairs and gold and crystal chandeliers; hundreds of high school students joined M.I.T. and Wellesley alumni to fill two-thirds of its 3,000 seats, and 600 alumni and their guests came to a reception for the Orchestra arranged by the M.I.T. Club of the Delaware Valley (James S. Rumsey, '40, President) and the Wellesley Clubs of Philadelphia and Wilmington.

The next night, in Dallas, alumni and members of the Orchestra were entertained at a series of eleven parties after the concert for an audience of 1,500 in Southern Methodist University's McFarlin Auditorium. And on Sunday morning, March 25, came a brunch for the entire orchestra and guests given by Mr. and Mrs. Cecil H. Green ('23) and Mr. and Mrs. Eugene McDermott. Dallas arrangements were in the hands of Bill C. Booziotis, M.Arch.'60, for the M.I.T. Club of Dallas.

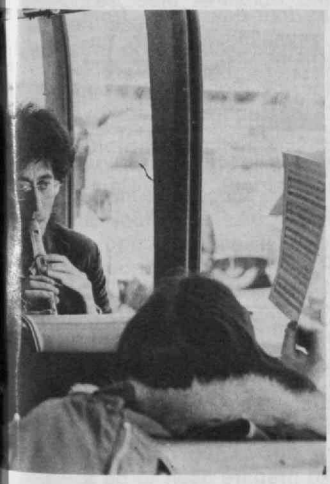
In San Francisco on March 26 the Orchestra found nearly 3,000 of the War Memorial Auditorium's 3,400 seats occupied; it was said to be the largest audience ever drawn to that auditorium by a college orchestra. More than 300 alumni stayed to meet the Orchestra after the concert at an after-concert reception. San Francisco arrangements had been made by Gaynor H. Langsdorf, S.M.'32, Denman K. McNear, '48, and Edward A. Merrill, '22.

In Los Angeles on March 30 Mr. and Mrs. Frank S. Wyle ('41) sponsored a before-the-concert party for alumni, and after the concert Mr. and Mrs. Leonard Matuner ('39)—he was arrangements chairman for the M.I.T. Club of Southern California—greeted guests at a reception for the Orchestra. In between, some 1,500 had crowded the Scottish Rite Auditorium for the concert.

But the climax remained for Chicago, whose stately Orchestra Hall has such excellent acoustics that it is called America's finest concert auditorium. The hall—in which members of the Orchestra




American Airlines
WELCOME
MIT
ORCHESTRA
CHICKEN HERE



could hear each other and at the same time all of the audience responses—spawned a rapport between audience and musicians; the Orchestra's exceptional performance was rewarded with a five-minute standing ovation.

All this was summarized by music critic Robert Marsh in the *Chicago Sun Times:* "It is a happy orchestra. It smiles as it plays. It takes obvious pleasure when a difficult passage goes well. And it brings to its music the sense of spontaneity and joy, the simple satisfaction in encountering the beautiful, that professional musicians so often lose, despite their dedication and skill.

"And when did you last see a cellist in the Chicago Symphony with a flower tied to the scroll of her instrument?"

Credit for the success of the Chicago appearance on April 1 belongs, too, to Mr. and Mrs. Joseph E. Dietzgen ('41), Mr. and Mrs. John Barriger IV ('49) and Mr. and Mrs. Robert W. Wright, Jr. ('50), who served as planners and hosts for the M.I.T. Club of Chicago; their receptions before and after the concert were attended by more than 400 alumni and guests.

"Raise vs. Spread": An Old Argument Confronts the Symphony

The lustre of the M.I.T. Symphony Orchestra's triumphant national tour *(see above)* was a bit tarnished shortly after the group's return to Cambridge: the Orchestra is an elite which grants membership "on the basis of ability, without regard to student status," wrote four leaders of other student music and drama groups in a letter to *The Tech.* The special attention and resources devoted to the Symphony Orchestra are "unfair to the other musical organizations which are far more representative of M.I.T."

Not so, replied Professor David M. Epstein, Conductor of the Symphony. Only 11 of this year's 95 players are from outside the M.I.T. community, as defined by Professor Epstein to include wives of students and former students, Wellesley students, and M.I.T. staff. (A few non-M.I.T. musicians substituted on the tour for members of the Orchestra who could not leave jobs or families for the 10-day period.)

In fact, explained Professor Epstein, the members of the Orchestra—and its Conductor—select themselves; there is an audition committee from the Orchestra which hears, with him, all players who seek places, and "only when players from the (M.I.T.-Wellesley) community do not meet the standard we have set," said Professor Epstein, "are chairs opened to the 'outside'." The number of non-M.I.T. players needed to make a first-rank musical experience for the Orchestra's members is fewer now than ever before—thanks, thinks Professor Epstein, to the wider understanding of M.I.T.'s interest in the arts among high school students and the general public which in turn has been generated by the excellence of such groups as the Symphony.

President Jerome B. Wiesner agreed, seeing the issue as another example of the dilemma of "raise vs. spread": to "support high standards in established organizations, or spread the available resources through a host of groups." Ultimately, he hopes, the Council for the Arts at M.I.T. (the Symphony tour was one of its first and most ambitious projects) can support equally effective activities by other groups in music, art, and drama.

Meanwhile, the Music Section is doing what it can to increase music-making opportunities for all students—chamber music ensembles, a chamber orchestra, more choral groups, a jazz workshop, and a Renaissance instrumental and vocal group are planned. "To put it plainly," wrote Dr. Wiesner in *The Tech,* "I think that M.I.T. must recognize the importance of making music in the life of every student qualified to do so, and we must provide the opportunity for all who want it."

The 25th Mexican Fiesta: The Pinata Finally Yielded

Bienvenidos, amigos. And it was a royal welcome to warm, sunny Mexico! It started on March 15 with the airport greeting by "Mr. M.I.T. of Mexico," Clarence M. Cornish, '24, holding a "Tech is Hell" banner that readily identified him to visitors. Its tempo increased throughout the three-day M.I.T. Fiesta in Mexico and the subsequent conducted tour to the Maya country.

A record attendance of 200 marked the gala party. But this wasn't the only record set by the M.I.T. Club of Mexico City, the Institute's oldest alumni club outside the U.S.A., in celebrating it 25th anniversary Fiesta.

The special occasion was honored by the presence of President Jerome B. Wiesner and Mrs. Wiesner and Corporation Chairman Howard W. Johnson and Mrs. Johnson. A delegation of 63 persons from the Class of '31 topped the figure of 35 set in 1960 by the Class of '21. And the all-time distance record was set by a visitor from Australia. Jonathan A. Noyes, Sr., '12, represented the earliest class; wed in New Jersey the previous Saturday and on their honeymoon were the former Miss Louise Greve and George F. Des Marais, '20.

There was an inspection of richly-appointed private homes and gardens. Once part of the 16th century monastery, the Miranda home is bounded by an ancient aqueduct. In contrast, the modern Quintana residence is one of the gorgeous estates on the once-bare lava beds.

Club President Ian M. Clark, '61, and Fiesta Chairman Herbert Weinstein, '66, who had collaborated on the plans which assured the success of the celebration, gave official welcomes at the University Club luncheon. Men received souvenir M.I.T. steins and onyx beavers, the ladies silver spoons. Enameled pins depicting M.I.T.'s Mexican beaver were an added gift from George F. Kosco, '40.

Here are details of other Fiesta events:

☐ Archeologists David Drucker and Mrs. Evelyn Rattray, wife of the late James J. Rattray, '48, a former president of the Club, led a tour of diggings in Teotihuacán. Here lived some 200,000 wealthy commoners, circa 250 A.D., near the famous pyramid area occupied by high priests of the era.

☐ A gay luncheon at the baby bullring of Cortijo de la Morena was punctuated by howls of laughter as alumni and their wives confused the live stock with unorthodox swirls of the cape. No injuries were reported to man or beast.

☐ Paul Gerard, '35, headed a delightful *charreada,* a sportsman's rodeo. Displays of riding, roping, bull-dogging, were followed by formation riding of costumed youngsters to a *mariachi* band's music.

☐ Spacious flower gardens surrounding the home of Luisa and Nish Cornish were a fairyland of lights and decorations for the *Noche Mexicana.* Native foods and beverages were served at tables on the lawn surrounding a four-man marimba, the dance platform and the *piñata,* a brightly uniformed beaver with a colorful sombrero. An award of appreciation—an exact copy of an ancient breast plate from the state of Oaxaca, fabricated in silver and gold by modern Mexican artisans—went to Dr. and Mrs. Wiesner. Nine alumni were designated "Eager Beavers" and given the coveted silver sombrero for attendance at four Fiestas: Randolph Antonsen, '35, Robert G. Bowie, '38, Carole A. Clarke, '21, Albert V. Dumas, '20, Eben B. Haskell, '26, Breene M. Kerr, '51, Jonathan N. Noyes, Jr., '42, Albert R. Pierce, Jr., '31, and Donald P. Severance, '38.

The elusive *piñata* defied destruction by crafty men and women bat-wielders until it was caught off-guard by Jack Larks, '52, and gifts for all spilled upon the lawn.

For half of those attending the Fiesta there followed a four-day tour from Merida, Yucatan, revealing Mexican antiquities of extraordinary size, beauty, and technical perfection. A highlight was a dinner given for the entire group by Arthur Ponce, '22, Director General of Cerveceria Yucateca, a leading beverage company, at the luxurious Club Campestre in Merida.—*Carole A. Clarke, '21*

Can M.I.T. Help Unlock a Treasure Chest for Mexico?

The success of technological transfer from a developed nation to a developing one depends as much on the latter as on the former. And that being so, how is a developing nation, without new technology, to select and attract the desirable technologies and so prepare itself to be a

more effective recipient in the future? This dilemma, expressed by several members of the M.I.T. Club of Mexico City during a 25th-anniversary-Fiesta seminar (*see above*) on March 15, found a ready answer: let an organization such as an M.I.T. alumni group, by collaborating with their alma mater, help to bring new technology to those who need it, making them ready to exploit science and engineering for their own needs.

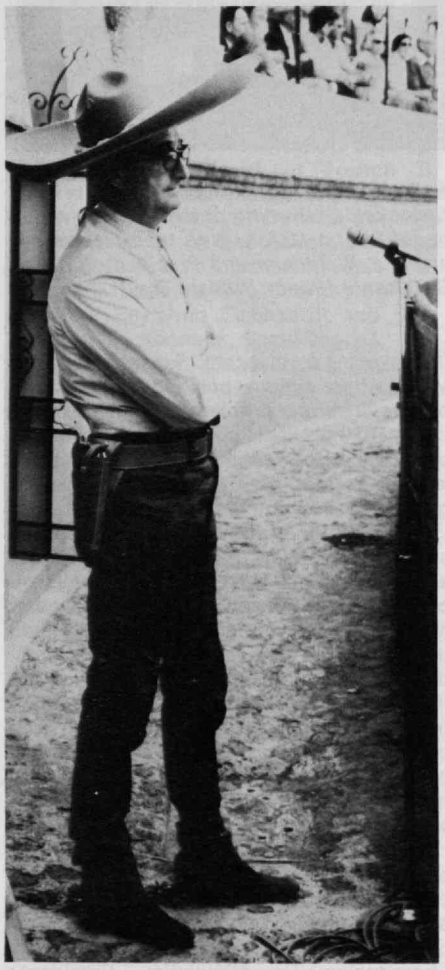
Indeed, President Jerome B. Wiesner, an honored guest for the Club's 25th annual Fiesta, suggested that the M.I.T. Club of Mexico City itself take the initiative of planning for a seminar on technology transfer; he pledged M.I.T. support for the effort.

Gordon S. Brown, '31, Institute Professor and Jackson Professor of Engineering, was intrigued by the plan. One key problem, he said, is that people's mental models of what technology can do and what must be done differ greatly—especially among people from developed and developing nations.

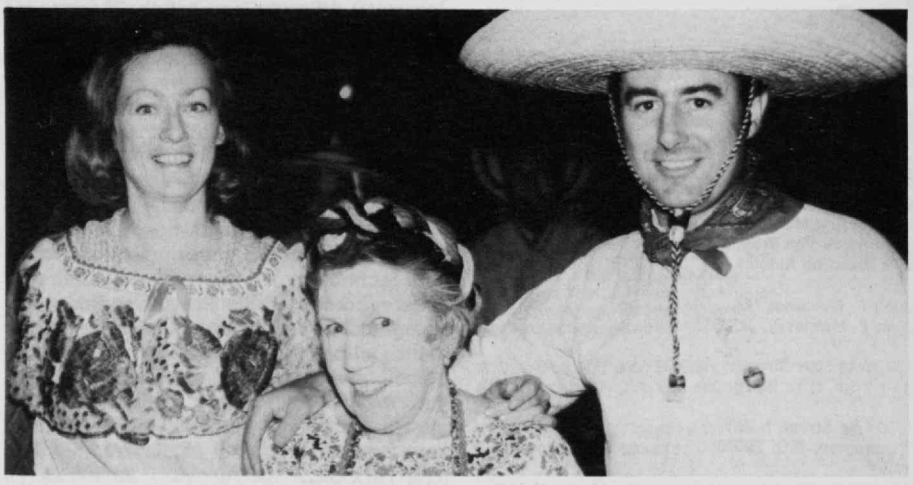
Mexico's dilemma as a developing country was made clear by Marco Murray-Lasso, Sc.D.'65, Professor of Engineering at the National University of Mexico: the cost to Mexico of paying for foreign technology—patent licenses, expert consultants, goods, and services—is many times the budgets of all the schools of engineering in that country. Thus the resources that could be helping Mexico become self-sufficient in technology are in fact leaving the country to reinforce the continued superiority of developed nations whose technology Mexico imports.

Yes, said Armando Santacruz, S.M.'54; an institution such as M.I.T. is like a treasure chest with a lock on it. The treasure is the knowledge and practical experience which the faculty and resources represent. The contacts with his school which an alumnus makes can be the key which opens knowledge of great potential benefit to a country such as Mexico. "But the lock," he said, "that is our inability to open up the flow of technology to Mexico."

Could it be done by an organization of M.I.T. and its alumni? Mr. Santacruz thinks so, and President Wiesner urged the M.I.T. Club of Mexico City examine the proposition—even suggesting that the experience gained by M.I.T. in such an effort would strengthen its own educational programs at home as well.



The M.I.T. Club of Mexico City's annual Fiesta is at once a reunion of old friends and an "insider's" view of a colorful foreign culture; four black-and-white pictures do justice to neither. Those on this page show the grandstand for the charreada *and (left) its master of ceremonies, H. Paul Gerard, '35; and two groups of old friends: above, Mrs. Donald P. Severance (left), John A. Lunn, '17, and Mrs. Conchita Pearson; and below, Mr. and Mrs. Ian M. Clark ('61) with Mrs. Carole A. Clarke (Mr. Clark is President of the M.I.T. Club of Mexico City). (Photos: Donald P. Severance, '38, and Carole A. Clarke, '21)*



Howard W. Johnson (right), Chairman of the Corporation, was enthusiastic; and so were his audience as His Excellency Kurt Waldheim (left), Secretary General of the United Nations, concluded his address to the M.I.T. Alumni Center of New York's "Evening at the United Nations" late in March. With them, above, are Mrs. Waldheim and President Jerome B. Wiesner (Photo: William Troy)

"One of the Great M.I.T. Evenings in N.Y.C."

"I urge you to seize this opportunity with enthusiasm and determination."

The opportunity is M.I.T.'s, "To contribute to the imperative task . . . to take up the priority problems of the poor nations of the world."

The challenger is His Excellency Kurt Waldheim, Secretary General of the United Nations, speaking to over 200 members and guests of the M.I.T. Alumni Center of New York at a gala United Nations dinner on March 27. (The full text of Secretary General Waldheim's address appears on pp. 73-74.)

Donald R. Miller, '50, General Chairman of the Alumni Center, agreed. Opening the evening's program, he referred to M.I.T.'s "prestigious position" as placing on the Institute problems which parallel those of the U.N. "In an age dominated by science and technology . . . the challenges facing both institutions are in great measure common to one another."

The same theme from Howard W. Johnson, Chairman of the Corporation, responding to the U.N.'s hospitality in receiving the M.I.T. group: though men for many years have had a "sense of the universality of science, engineering, and the world of technology in the service of the aspirations of the whole of mankind," he said, this idea has never had such acceptance, or importance, as today. He called "the growth of science as an international community a major catalyst" for world understanding.

"Coping with the development of science and technology and their transfer is an essential task of the United Nations—and of educated people in every country of the world," said Mr. Johnson.

Introducing Dr. Waldheim, President Jerome B. Wiesner assured the Secretary General of M.I.T.'s strong commitment to international studies and international affairs; indeed, he said, as many as 50 members of M.I.T.'s faculty and staff may be overseas on any day he chooses to count, and "science and technology in the service of mankind" is a "recurring theme" at M.I.T., where many faculty and students sense a "great need to understand the role and meaning of science and technology in international affairs."

The spectacle of the East River from the Delegates' Dining Room and the ambience of old friends meeting new friends helped make the formal speeches informal, and as the meeting adjourned many guests must have agreed with Mr. Johnson: "one of the great M.I.T. evenings in New York City."

An Immunologist Comes to M.I.T.

The first major appointment to the new Center for Cancer Research has been announced: Dr. Herman N. Eisen, a noted immunologist who is Head of the Department of Microbiology in the Washington University School of Medicine, will come to M.I.T. during the summer.

He will be Professor of Immunology in the Department of Biology, and Senior Scientist in the Center for Cancer Research.

Dr. Eisen studied at New York University (A.B. 1939, M.D. 1943). Since then he has worked at the Sloan-Kettering Institute and taught at New York University, Columbia University, and Washington University—where he was Professor of Dermatology before taking his present post. He is well known for work in immunization and immune response—a field related to cancer through the genetic changes that are known to be brought about by virus invasion of cells.

A $1.16 Million Lifetime Cancer Research Grant

David Baltimore, Professor of Biology at M.I.T., has been assured a new form of tenure guaranteed not by the Institute but by the American Cancer Society: he is now designated as American Cancer Society Professor of Microbiology, and the Society guarantees major support for him for his cancer research career.

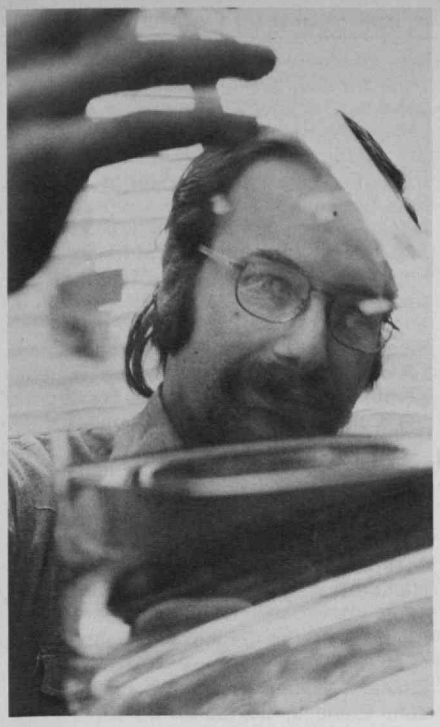
At 35, Dr. Baltimore can look forward to 30 years in research and teaching before normal retirement, and the American Cancer Society will provide $1.159 million toward Dr. Baltimore's support over that period.

The award recognizes Dr. Baltimore's already substantial contributions to virology—his discovery of the enzyme responsible for multiplication of the polio virus and his later discovery of reverse transcriptase; the latter is an enzyme found in tumor virus particles which reverses the normal flow of information in biological systems. Professor Baltimore and his wife, Dr. Alice S. Huang, have together demonstrated the presence in certain virus particles of enzymes critical to the viral genetic system.

Dr. Baltimore's Ph.D. degree is from Rockefeller University, and he worked at the Salk Institute before coming to M.I.T. in 1960. He holds the Gustav Stern Award in virology (1970), the Warren Triennial Prize of Massachusetts General Hospital (1971), and the Eli Lilly Award (1971).

The American Cancer Society Professorship was announced by Dr. Milford D. Schulz, President of the Massachusetts Division of A.C.S. The awards are based, he said, "on the accepted premise that science is dependent upon men who have ideas, who are allowed to think, question, develop theories, and subject their ideas to the rigors of scientific experimentation.

"Such workers must be free to alter or discard theories when new facts demand it," said Dr. Schulz, "and they must be assured of the opportunity to work in an environment which will provide such freedom."



With funds of at least $1.159 million guaranteed through his lifetime as American Cancer Society Professor of Microbiology, David Baltimore will devote his research career to studying the growth of viruses which either can cause cancer or provide models for understanding cancer-causing viruses. He will maintain his virus research laboratory in the M.I.T. Biology Department and will also direct a tumor virology group in M.I.T.'s new Center for Cancer Research. (Photo: Mark PoKempner)

Henry P. McCarthy, 1890-1973

Henry P. McCarthy, who coached basketball at M.I.T. from 1923 to 1948 and while doing so founded the Boston-area high school basketball competition still known as the "Tech Tourney," died at Quigley Memorial Hospital in Chelsea, Mass., on April 6. He was 83.

Mr. McCarthy's name was synonymous with the growth of interscholastic basketball in New England, and he has also been credited with creating the climate of interest which fostered professional basketball in Boston. After he founded the "Tech Tourney" (the New England Interscholastic Basketball Tournament) in 1926—it moved to the Boston Garden from M.I.T. in 1944, and he continued as its Director until 1971—Mr. McCarthy conducted 73 basketball tournaments, probably more than anyone else in the country.

Mr. McCarthy first came to M.I.T. in 1922, having earlier coached basketball and taught physical education in schools in Arlington, Winthrop, and Revere, Mass., Gary, Ind., and Salt Lake City. He became Director of Physical Education and basketball coach in 1923, and for 25 years thereafter he was the principal architect of the Institute's physical education program devoted to broad student participation at a variety of levels and in many different sports.

Individuals Noteworthy

Professional and corporate changes: **Robert F. Weiss**,S.M.'59, named Vice President for Applied Technology at Avco Everett Research Laboratory, Inc. . . . **John T. Alexander**,'52, named Executive Vice President and General Manager of the Red River Valley Cooperative, Inc. . . . **Robert A. Sherman**,S.M.'55, elected a Director of Eastman Kodak Co. . . . **Peter Samton**,'57, promoted to Design Director of Gruzen and Partners . . . **Joseph S. Gaziano**,'56, elected President, Chairman of the Board, and Chief Executive Officer of Tyco Laboratories, Inc. . . . **George E. Best**,'34, elected Vice President and Secretary-Treasurer of the Manufacturing Chemists Association . . . **Kermit Greene**,'47, named Divisional General Manager of St. Regis Paper Co.'s Laminated and Coated Products Division . . . **Robert L. Johnson**,'38, elected Advisory Director of New England Merchants Bank . . . **Robert S. Woolworth**, '51, admitted to the partnership and appointed Vice President of Joseph S. Ward International, Inc. . . . **Jess L. Belser**,'52, elected a Director-at-Large and member of the Executive Committee of the Fibre Box Association . . . **Edwin S. Worden**,'31, named Vice Chairman of the Board of Raymond Eisenhardt and Son, Inc. . . . **Kenneth Spaulding**,'41, appointed Manager of American Smelting and Refining Co.'s new copper refinery in Amarillo, Texas . . . **Gerald Peretsman**,'50, named Executive Vice President of Downe Communications, Inc. . . . **James Tewksbury**,Ph.D.'53, to Vice President of the energy division of Foster Associates, Inc. . . . **Richard J. Hayes**,'54, named Vice President, Copier Product Development, Xerox Corporation . . . **Robert T. Parry**,'41, to Vice President-Employee Relations, Boston Edison Co.

Awards and honors: To **Clifford M. Wallis**,S.M.'29, the University of Missouri-Columbia College of Engineering's annual Honor Award for distinguished service in engineering . . . **Herman Feshbach**, Ph.D. '42, recipient of the 1973 Tom W. Bonner Prize of the American Physical Society . . . to **Michael S. Feld**, '63, a Sloan Research Fellowship from the Alfred P. Sloan Foundation . . . **John R. Kane**,S.M.'40, named Engineer of the Year by the Peninsula Chapter, Virginia Society of Professional Engineers . . . John Simeon Guggenheim Memorial Foundation Fellowship awards presented to **Richard F. de Neufville**,'60; **John N. Newman**,'56; and **John E. Savage**,'61 . . . to **Joseph A. Lombardo**, '55, The National Aeronautics and Space Administration's Exceptional Service Medal . . . **Arthur F. Merewether**,S.M.'25, presented the 1972 Gorrell Award of the Air Transport Association . . . to **Rocco A. Petrone**,'52, the National Aeronautics and Space Administrations Distinguished Service Medal.

University Appointments: **David B. Lipsky**,'65, elected Associate Professor of Industrial and Labor Relations in the New York State School of Industrial and Labor Relations at Cornell University . . . **Emily L. Wick**,Ph.D.'51, named Dean of the Faculty and Professor of Chemistry at Mount Holyoke College . . . **Wil-**

liam A. Klemm,Sc.D.'46, named Professor of Chemical Engineering at Indiana Institute of Technology.

M.I.T. Appointments: **Gordon S. Brown**, '31, appointed Institute Professor of Electrical Engineering . . . **Martin Deutsch**, '37, appointed Director, Laboratory for Nuclear Science **Peter T. Demos**,Ph.D.'51, appointed Director of M.I.T.'s Bates Linear Accelerator and Professor in Department of Physics . . . **Yau Wu**,S.M.'60, appointed Visiting Associate Professor in Mechanical Engineering Department.

Professional Societies: **Reece H. Wengenroth**,'42, installed as Vice President of the Consulting Engineers Council of Illinois . . . **Max D. Sorota**,S.M.'50, elected to the Boston Society of Civil Engineers.

Deceased

Joseph C. Riley, '98, April 27, 1973
Nathaniel K. B. Patch, '01, September 14, 1969
Shepard Gilbert Emilio, '07, February 20, 1973
E. Stanley Wires, '07, March 30, 1973
John Gianella, '08, March 15, 1973
Clifford B. Russell, '08, September 28, 1959
Atwood C. Page, '10, March 7, 1973
Ernest L. Osborne, '14, March 20, 1973
George R. Hale, '16, April 3, 1973
Carl G. Whitaker, '16, August 30, 1972
Frank S. Carson, '17, June 7, 1971
William Nelson, '20, December 8, 1972
C. Ford Blanchard, '22, March 12, 1973
Thomas H. Gill, '22, April 17, 1973
Duncan G. McGregor, '22, December 6, 1970
Harold C. Wagner, '22, January 13, 1973
George H. Hurley, '23, February 22, 1973*
Rowland J. Robinson, '23, November 3, 1962
Alfred L. Chardon, '24, October 7, 1972
John F. Hennessy, '24, April 24, 1973
Walter C. Thee, '24, December 23, 1972
Arthur E. Bysshe, '25, September, 1972
Laurence G. Cumming, '26, February 24, 1973
James Q. Du Pont, '26, February 15, 1973*
Robert F. Flaxington, '26, November 28, 1972
Edwin J. Gohr, '26, March 9, 1973
Roderick L. Jerrett, '26, July 2, 1971
Marvin H. Dixon, '27, January 29, 1972
Alanson W. Olmsted, '27, April, 1972
Virgil Quadri, '27, June 2, 1972
Burdett P. Cottrell, '29, October 1, 1972
Thomas E. Dadson, '29, May 11, 1972
Robert Sealy, Jr., '30, October 9, 1972
Joseph R. Stevens, '30, March 14, 1972
Herman Albert, '31, January, 1971
Theodore R. Freeman, '32, January 5, 1973
Harry W. Gabar, '33, February 13, 1973
Samuel L. Benedict, '34, February 28, 1973
Andrew T. Dempster, '34, April 9, 1973
Frank P. Wardwell, '38, August 11, 1970
Gage H. Crocker, '43, March 26, 1973
Richard D. Wilson, '43, September 18, 1972
Michael A. Lintner, '63, April 2, 1973
Philip B. Kaplan, '67, May, 1972
Joseph H. Lunacek, '70, July 13, 1972
*Further Information in *Class Review*

Class Review

96

On National Inventor's Day, Dr. **William D. Coolidge** received another award. Mayor Duci presented him with a plaque from the citizens of the city and gave him the honorary title of "Schenectady Patroon." To mark the occasion Dr. "Will" also received a collection of letters of congratulations, including messages from President Nixon and Governor Rockefeller.

The mails also brought a newspaper clipping with an excellent picture of our centenarian, **Richard O. Elliot**, showing his great-great-grandson the intricacies of the rigging of the sailing vessel which decorated the 100th birthday cake. There was a five-generation gathering of the clan with guests from Maine to Mexico.—**Clare Driscoll**, Acting Secretary, 2032 Belmont Rd., N.W., Washington, D.C. 20009

On National Inventor's Day (February 11, 1973), Schenectady, N.Y., Mayor Frank J. Duci (right) presented the award of "Schenectady Patroon" to 99-year-old Dr. William D. Coolidge, director emeritus of the General Electric Research Laboratory. Dr. Coolidge holds 83 patents, and counts among his inventions the Coolidge X-ray tube that made possible modern medical and industrial X-ray technology

03

Recently I received an interesting letter from one of our classmates that brought home to me the prominence of our classmates. This is in particular regard to their success in their varied careers in life. We proudly remember all of you at our famous 50th Class Reunion. Accordingly, in our future Class Notes, we will welcome more news of classmates in the hope of stimulating Class spirit in M.I.T.

To deviate a bit, our recent New England wintry blasts have given up to trees now bursting forth with blossoms. Our three remaining classmates in the Boston area are rejoicing to be able to enjoy the long-awaited sunshine. Ironically enough, our M.I.T. research engineers have not yet succeeded in isolating lost atmospheric heat for seasonal and commercial use although tremendous strides have been made in ultimate control of light and sound.

The unfortunate news of classmates passing on continues. **G. Huntington Clapp** of San Pedro passed on April 1965. . . . **Arthur Gibbs** of Brockton, Mass., departed August 3, 1971 and **William C. Lounsbury** of Janesville, Wisc., died December 12, 1972.—**John J. A. Nolan**, Secretary, 13 Linden Ave., Somerville, Mass.

05

Because of a continuous curiosity for several years as to the doings of **George Whiting** of Baltimore, I "shot an arrow into the air," and it hit the spot. We have a very dear friend who is a resident of Sandwich, but spends his winters in Baltimore. He happened to have known George through a luncheon club to which they both belonged. He phoned Mrs. Whiting, and I quote from his report, "You are correct that he is becoming increasingly deaf and blind as well. He is always looked out for by the members of the club and highly respected—a lovely spirit." This will answer the questions which several of his classmates have asked me.

Isabel and **Chester Shaw**, who used to cover the U.S.A. in a camper, are firmly settled back home in Abington, Mass. They celebrated their 60th wedding anniversary last August. Chet apologizes for his writing because of cataracts not yet ready for operation, but compared with mine, his writing is "tops." Can any other '05er brag of a longer wedded life?

Herman Eisele modestly reports a new honor which, however, has been in the making for the past 65 years. He says "this shows what can happen to a fellow when he gets old." A clipping from the *Cleveland Press* tells the story. "Herman Eisele, 91, still practicing as a consulting engineer, will be honored at a luncheon Saturday by the Ohio Society of Professional Engineers. The Society will present Eisele with its Ohio Senior Engineer Award in recognition of the number of years he has been active in the field. Eisele continues to work full time in an office located in the Engineers Building. He has been operating his own business since 1908. When he opened his own firm, he concentrated his efforts on making labor-saving machinery and factory equipment. In 1931 Eisele expanded his services when he registered as a patent attorney. This allows him to practice in the U.S. Patent Office, and he currently has some patent applications filed with the office. The only way in which Eisele has limited his business is that he no longer accepts new clients. Eisele shares his office with his daughter, Mrs. Ostrud Higgins, who helps him with secretarial work."

Last month I wrote of the death of **George Rhodes** but had no details. Through my daughter in Mountainside, N.J., and his in Glen Ridge, I now have some. In fact, I would have had his whole life story had I known he was in *Who's Who in Commerce and Industry* and *Who's Who in America, 1944-1951.* He had been a widower for 34 years, living separately, but on the same property, with his daughter in Glen Ridge. Most of his business life was with Ford, Bacon and Davis, consulting engineers in New York City. Surviving him are two daughters.

Rummaging around in my files, I came across Percy Goodale's (remember him?) Christmas card for 1952. His message was "One million wishes to get back to common cents" and there was a bright and shiny cent attached. Oh, if there were now 100 cents in a dollar, and how we do need good old fashioned "common cents."

I have just learned of the death of **C. Robert Adams** on July 25, 1971. No further details.—**Fred W. Goldthwait**, Sec-

retary, Box 281, Center Sandwich, N.H. 03227; **William G. Ball**, Assistant Secretary, 6311 Fordham Place, Bayshore Gardens, Bradenton, Fla. 33505

07

We received word of the death of two classmates this month. Mrs. Cumings wrote, "My husband, **Paul L. Cumings** asked me to send you this account of Mr. Wires' death. They were classmates and soon after graduation from M.I.T., Mr. Wires established his tile company—the E. Stanley Wires Co. My husband joined him and remained with him until 1945. Their company constructed the M.I.T. swimming pool, the pool at Wellesley College and dormitories at Harvard."

The Wellesley Townsman for April 5, 1973, wrote of Mr. Wires, "Private services were held Tuesday morning for **E. Stanley Wires**, 88, who died March 30, 1973, at his Linden Street home.

"He was a recognized authority in the field of tiles and ceramics and a specialist in that trade for most of his life. In 1959 he presented the Smithsonian National Museum in Washington an unusual collection of decorated tile representing the history of ceramic tile. It included pieces that Mr. Wires collected internationally through the years and is now displayed in a room named in his honor. After graduation Mr. Wires was Director of the Maugus Club, the Wellesley Club and the Wellesley Country Club. A member of the Town Advisory Committee, he was also a member of the School Survey Committee and Vice President of the Tile Contractors Association of America. Husband of the late Helen Mead Wires, who died in 1966, his survivors include two sons, two daughters, 15 grandchildren and seven great-grandchildren.

We must unfortunately report the death of another classmate. Mrs. S. Gilbert Emilio wrote of her husband's death on February 20, 1973. She writes, "He faithfully served the Town of Gilford, N.H., for many years as Selectman. The last ten years of his life were devoted to Gilford as Auditor, Supervisor of the check list and as a member of the Planning Board.

The Gilford newspaper had this obituary, "**Shepard Gilbert Emilio** was a retired engineer. Prior to moving to Gilford 33 years ago, he was a curator at the Peabody Museum in Salem. He had also, during his earlier years, done mining engineering out West. He was a member of the Unitarian Church of Salem; a member of the Essex Institute of Salem; member of the Salem Marine Society, and Nutthall Ornithological Society of Cambridge, Mass. He was a life member of the Thompson Ames Historical Society. He is survived by his wife Dorothy C. Emilio, two sons, a daughter, a step-son and daughter and two step-grandchildren, a sister, four grandchildren and two great-grandchildren.—**Margaret Kelly**, Class Notes Editor, E19-430, M.I.T. Cambridge, Mass. 02139

11

I was recently mailed two hats and a mobile made by **Frank Smith** from coconut tree fronds in Honolulu. Starting last fall he took up weaving of palm hats as a hobby with an old Samoan woman as a teacher. His workmanship is beautiful. The mobile consisted of five palm leaf birds suspended by almost invisible nylon filaments suspended on wire spreaders. It is now hanging in the archway between my dining and living rooms, and sways with every breath of air. Frank is something of an artist and used to make very fine pictures by the silk screen process.

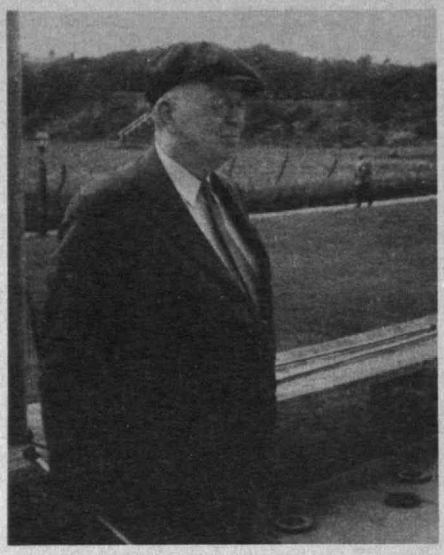
The Alumni Office has sent me three address changes as of March: Thomas S. Killion, P.O. Box 131, Bay Ave., Green Harbor, Mass. 02041; Harry E. Lake, 10117 Desert Rock Dr., Sun City, Az. 85351; Osborn H. Shenstone, c/o J. C. Shenstone, 225 Harrow Circle, Birmingham, Mich. 48008.

I regret to have to report two deaths: **William O. Whitney**, 969 Lake Dr., Dunedin, Fla., 33528. He had suffered for a long time with crippling arthritis. He passed away January 5 of this year. . . . **Samuel L. Hayes**, 2139 Norton Rd., Charlotte, N.C. 28207. Samuel, who graduated in chemistry, was born in Thomasville, Ga., and prepared for Tech at Virginia Military Institute. He spent his business life in textile sales and technical work in dye stuffs.—**Oberlin S. Clark**, Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

12

It is time to send you the news I have garnered from the past month resulting from a request and which I am happy to say shows that many of our number are still willing and able. Thank you every one, for your contributions.

Henry Foley writes from Birmingham, Mich., "I am glad to say that both my wife, Rosemary, and I have been blessed with reasonably good health over all these years, although recently we have noticed signs that time is marching on. Last February, however, I suffered a very slight stroke but seem to have satisfactorily recovered, as there have been no visible after-effects. But the doc says it is time to quit shoveling snow or climbing ladders. Also after several trips abroad and auto tours across the U.S. and Canada we are planning no tours this year. Our four sons are most active. Henry, our oldest, is still Professor of Nuclear Physics at Columbia. Last summer an anti-war group threw a bomb and staged a sit-down in the Physics Lab, serving notice on the faculty either to abandon all war projects or get rid of Professor Foley. They did neither and the whole thing blew over. Our second son, Arthur was in the U.S. State Department for 25 years, mostly overseas, with the last six years as a N.A.T.O. officer in France and now in Philadelphia with H.U.D. Our third son, Robert, is in the Overseas Division of Ford Motor. He spent over six years in Europe and then transferred to the U.S. office of the same division. Last summer he met with King Hussein in Jordan to complete a big truck deal, and came home with a beautiful watch bearing the royal insignia. Our youngest son, John, is happily engaged with his own law practice in Kalamazoo, Mich. He has a lively family of six children from 5 to 15 years. Personally, my chief pleasure is as a member of the Senior Men's Club of Birmingham, a group of 325 who are mostly engineers and professional men. I concentrate primarily on the advantages of correct bridge bidding and hope I have learned the answers by now."



Bates Torrey, '12

Colonel **Harold Mabbott** sent us the following review of his early career including his army experiences during both World Wars. "On graduation from Course II, I got a job with the old Peerless Automobile Co., in Cleveland under Don Stevens, '11, supervisor of student engineers. After a few months in the drafting room. I was transferred to the shop which was not a multiple-operation process at the time. I used to say that there was no other car like the Peerless, not even another Peerless. Business fell off in 1914 so I resigned and worked for a short time with Pratt and Whitney in Hartford, Conn. I could see little future there so I went to Boston and became an instructor at the Y.M.C.A. Engineering School at a salary of $100 a month. When one of my students told me he was joining the Army at $144 a month plus a free house to live in, I took the exams myself and entered the Coast Artillery, a branch of the army which soon accepted the anti-aircraft assignment. I soon went to France and became an instructor in the anti-aircraft school just outside of Paris. Soon World War I was over and I was in Paris the night of the armistice and happened to be there again when World War II ended. There was much more fun, however, at the celebration in 1918. "I served in Panama and Hawaii. During World War II, I was on duty in England, France and Belgium. In 1929, the army sent me to M.I.T. for a year of electrical and sound course training. I retired in 1941, and have since lived in Swarthmore. My wife died there in 1958."

Bates Torrey, of Syracuse, whom many of us remember as a star on our Class baseball and football teams, writes a

Jonathan Noyes, '12, Conchita Pearson and President Wiesner pause a moment at the 25th M.I.T. Fiesta in Mexico City this past March.

brief note. He is not in good health and is living a quiet life at home alone. Our very very best wishes, Bates! . . . **John Hall** sends the following, thereby fulfilling his promise to make a contribution. "I have little personal news of any interest. I do some gardening, tinker with small jobs about the house and try to keep up with current history that whistles about our ears. But even the *New York Times* carries so much news that is not fit to print that we are considering cutting down to Walter Cronkite, *Reader's Digest* and *National Geographic.* However, an event of special interest to public health, where, as you know, I have spent most of my life, has come about recently here in New Jersey. A "Fluoridation Study Commission" appointed by the governor, has issued a report whereby it is recommended that this public health procedure be required on all potable water supplies. Seven other states have already required it, but it is the first real promise of it here for some of us who have been working on it for a long time.

"I was involved with early chlorination of water supplies, both in and after M.I.T. You may remember one William T. Sedgwick who pioneered this feature at the old Lawrence Experiment Station. I was also in at the start of pasteurized milk and, when Health Officer of East Orange in 1917, my department was the first in the State to require such treatment of all milk before sale. These two, plus fluoridization, are the three outstanding mechanical, non-medical accomplishments in the field of public benefit for everybody. They are simple, relatively cheap, safe, and remarkably effective. I want my record to show that I had a part in all of them. To have seen, and now to look back at such things, are some of the advantages and privileges of living long enough to get older. Now, a bit of propaganda. One part per million of sodium or other fluoride added to public water supplies prevents up to 60% of tooth decay in children who drink it at an early age. It benefits them for life. It also otherwise benefits adults. So when you old fellows hear it is being proposed in your vicinity encourage it with all your energy and enthusiasm, thus helping to promote better teeth and general health. I rest my case." Thank you, John, a special award to you from our Class!

John Noyes writes how much he enjoyed the M.I.T. Mexican Fiesta in March where he was our only Class representative. He sent me some colored photos to show what a good time everyone had. . . . **Chet Dows** writes that they have both been well. The high wind storm on Lake Erie in mid-March caused much damage but the new sea wall at their lake cottage stood firm throughout its 275' length, although some of the neighbors sustained real shore damage. Chet says that the lake is still some two feet higher than it has been in 100 years and that it will not crest 'til June. They planned to move down in early May. . . . **Cy Springall** and Marjorie have kept in reasonably good health and reviewed their activities last summer. They drove with relatives to New Hampshire's White Mountains and on to their favorite state of Maine after a stop at Rangeley Lake and then to see relatives in Dexter. They then renewed their friendship with Mt. Desert Island where we have spent some 30 summers, then on to Palermo. Marge says, "The score for our six-day trip in Maine was 44 people in 14 different places. Not bad for a couple of 'has beens'."

Frank Caldwell writes from West Hartford, Conn., that he continues to be in good health and expects to continue his golf this spring and summer. They have taken no trips recently. . . . Carl Rowley and Ruth advise that they are both well. They planned to leave, as usual, in late May for their summer home at South Harwich, Cape Cod and ask that any classmates in the vicinity visit them. Carl says, "Retired over a year ago and how the weeds grow! I just grow older." . . . And **Al Harkness** merely writes, "Best wishes!" . . . **Harold Brackett** and his niece, Eleanor Forbes spent six weeks in March and April in Florida as usual, staying both near Sarasota and Delray Beach. Says there is very much multi-story condominium construction and traffic everywhere. Their primary interest is, of course, surf fishing. This year the wind was mostly too heavy and the surf so great that only sheltered spots were productive. They did get a few sheephead, flounder and whiting, ranging up to 14", but no mackerel. . . . **Phil Jones** is still enjoying life in Naples, Florida. As previously reported, he was married again three years ago to a girl from Boston after four years alone after his first wife died. Phil says they belong to the Naples Duplicate Bridge Club and the "Friends of the Library." Phil was chosen to head up a drive for a new library a few years ago and as a result the new Collier County Library was erected. Although he was a most successful electrical engineer, Phil's avocation is philosophy. He published, in 1964, a small book, *The Nature of Knowledge,* and he is still writing. . . . **Howard Cather** vacationed as usual this winter with several friends at Siesta Key in Florida and is planning to repeat next year. . . . **Don McCormack**, who celebrated his 89th birthday last month writes from his new home in Salisbury, Md., sending me a fine sketch of a Canadian covered bridge, also a clipping telling of the tremendous damage at the new John Hancock Building in Copley Square, due to breaking out of many windows during every heavy wind. Happy Birthday, Mac! . . . **Cornelius Duyser** is now nearly 89 years. His chief trouble is arthritis and he was glad when winter was over, but writes that he is definitely "alive and very much kicking." He visits his nearby family frequently, but this year has given up gardening after a poor year in 1972. . . . Jim Cook is still able to get about and enjoy life. His letter describes the New England Aquarium on Atlantic Ave., Boston, which he says is well worth seeing, also the reconstruction of the waterfront here where several high-rise apartments will be built. His two daughters are presently touring England with friends.

Sadly, I am reporting the sudden and unexpected death of **Jabez H. Pratt** of a heart attack on March 12, 1973. Jay was, until recently, our Assistant Secretary, a most active alumni and one of my best friends. Jay and Priscilla were vacationing at the time at their favorite vacation spot in Acapulco, Mexico where together, they went annually for many years. Our deep sympathy to his wife, Priscilla, and to his son, Ryder and family, including four grandchildren, who live in St. Louis, Mo. . . . I must also advise of the passing of **Lawrence** (Shorty) **Walker** of Shelton, Conn., also due to a sudden heart attack on December 22, 1972. Shorty and his wife were visiting their son William and family for Christmas when the seizure occurred. He was active and happy till the last moment.

I have just learned that **Bertrand F. Brann** of Winthrop, Maine, a retired instructor in chemistry at the University of Maine, died on May 16, 1972. No further information is available. . . . We have also been notified of the death of **Edmund Lewis Homan** in Marblehead, Mass., on July 6, 1972. He took a special course in metallurgy and spent most of his career with General Electric Co. Our sympathy was sent to his wife, Helen. He had no children.

In the last issue we included news received from three widows of classmates. Here are additional contributions. . . . Mrs. **Robert Cox**, Helen, has recently moved to Carmel, Cal., (Box 1099). She enjoys reading the *Review* each month, both the news and articles. Last summer, she stayed two months at the dude ranch in Wyoming where Bob spent most of his career. "There I could breathe fresh, clean air, see open country and the sparkle of the stars at night. I spent many an hour on horse back and hiking about. In April, I returned to Wellesley to assist in the strenuous job of raising a fund of nearly $8 million which is being started. It is fine that M.I.T. and Wellesley are sharing in some classes and joining in their musical interests. Our son, Bob Jr., is a hard working pathologist and has five children. My Bob would be amused at my efforts here as a journalist." . . . Mrs. **John Lenaerts**, Marion, moved from her apartment in Venice, Fla., to Mease Manor, Dunedin, a retirement home, as previously reported. She writes she has

made many friends and enjoys the social life very much. . . . Here is a note from Louise Rhodes, whose husband, **William Rhodes** of Bronxville, N.Y., died recently. "When we suffer a great loss, all advice is to look ahead. I find it a great comfort to look back and recall our recent Bermuda trip, even though Bill was not in robust health. This island was most enjoyable. Almost before I had unpacked, Bill was involved in serious conversation with some man in the lobby of our hotel. I often felt, while in retirement, he missed the company of men of his type." . . . Mrs. **Rudolph Fox**, Karen, died last year, only two years after Rudolph. They lived in Denver, Col., and are survived by one son and one daughter, both college professors.—**Ray E. Wilson**, Secretary, 304 Park Ave., Swarthmore, Pa. 19081

13

When you read these Notes the 60th Reunion of M.I.T., Class of 1913 will probably be in session on campus in Cambridge. We have received a very interesting letter from Marguerite Rollason (Geoff's widow). She states that she enjoys reading the monthly issues of the *Technology Review*. Marge wishes that she and "Geoff" could be with us at our 60th Reunion. Also, she enclosed a copy of a citation she received from President Nixon for Geoff's services during World War I and II. We quote: "The United States of America honors the memory of **Geoffrey M. Rollason**. This certificate is awarded by a grateful nation in recognition of devoted and selfless consecration to the service of our country in the Armed Forces of the United States." We all shall miss Geoff and Marge, and we are very much pleased that our Government appreciates the helpful service he rendered.

We were greatly pleased to receive a letter from **Robert Tullar** and we quote: "I sent my class dues and thought I indicated we would probably attend the 60th. We expect to go with Mr. & Mrs. **Emerson Bray**. Their address is 312 State Rd., Upper Darby, Pa. 19082. We will probably fly. Everlasting thanks for your tireless work for the Class of '13." . . . We are saddened to learn that Leila and **Herbert Shaw** will not join us in our festivities at our 60th Reunion. We quote Herb: "We are sorry that we cannot be with you folks this year for our 60th Reunion, but we do not think it would be wise for us to try to make it. Leila is having a lot of trouble with a very lame knee that slows down her walking very much, so much so that she must use a cane all of the time when away from home. Also, we would not care to try to drive into or around Boston. You grew up driving in Boston, and know your way around the city, but we would be lost there, as the last time we were there was around 1946. We hope to go North for a vacation in the fall, and should we be near you folks we will look you up for a short visit. Give our best to Roz and the gang."

We are wondering if you thirteeners throughout the country have been fortunate enough to see the several broadcasts each month over ABC-TV, a program coordinated by the Shell Oil Co., M.I.T., and the several medical researches in some of our outstanding hospitals. These programs combine science, technology, and medical treatments for the benefit of new borns as well as ailing adults. This series of co-ordinated research is listed as "What About Tomorrow?"

There is a monthly dinner meeting of the Alumni Advisory Council which is very interesting and informative as to the plans and projects planned by the M.I.T. Administration. The representatives on this Council are **Ellis W. Brewster**, Dr. **Francis Achard** and your Secretary, **George Philip Capen**. The Council meeting of March produced some interesting changes in the personnel of the Alumni Association. Frederick G. Lehmann, '51, (former secretary) has been appointed a new financial Vice President and Treasurer of the Alumni Association, also Richard A. Knight, '47, (formerly Assistant Secretary) has assumed the responsibility as Secretary of the Alumni Association.

It is our very sad duty to report the passing of our beloved classmate, **Philip B. Terry**, and we quote the following published notice: "Philip B. Terry of 47 Lazell St., Hingham, Mass., died March 22, 1973. Mr. Terry was born in East Bridgewater, Mass., and was 81. He had been a Hingham resident for over 50 years. Mr. Terry graduated from M.I.T. with a degree in Chemical Engineering and worked for Dupont as a Chemical Engineer before joining Semco Industries in 1921. He was Chairman of Board of Directors of Semco Industries, Inc., and Spaulding Co., Inc., Randolph, Mass., Printing Services and Distribution of Graphic Arts, Business, and Engineering Products. He was a member of the Town of Hingham's Advisory Board, Capital Outlay Committee and Tree and Park Committee. Mr. Terry was a member of the Boston Rotary Club since 1928 and of The Appalachian Mountain Club and the American Chemical Society. Survivors include his wife, Marion (Spaulding) Terry of 47 Lazell St., son Dr. Philip B. Terry, Jr. of Hingham; and daughters, Mrs. Alice (Terry) Albe of Wollaston, and Mrs. Nathaniel S. Terry of Hingham. He is also survived by eight grandchildren and five great grandchildren. Funeral services were private."

Also on June 23, 1972, **Victor Mayper**, 324 E. 41st St., New York, N. Y. 10017 passed away. . . . **George E. Hodge**, 14 Thackery Rd., Wellesley Hills, Mass. 02182 departed from this world on February 22, 1973. We learned from one of our letters returned that **Seaphes D. Shinkle**, of Awosting, N.J., was deceased on July 12, 1971. We have sent a note of sympathy to the families of our departed classmates. Time is marching on, so write your Secretary often.—**George Philip Capen**, Secretary and Treasurer; **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

14

It was good to exchange some letters in March with **Harold Mayer**. Our correspondence arose out of the different new addresses for him that appeared in the 1914 news in the March/April and in the May issues of the *Review*, and resulted in confirming the address in the latter issue. Harold sent a snapshot which shows him looking good. His wife died nine years ago, and his only close relative is his son Dennis, who was graduated from the Medical School of the University of Oregon in June, 1971, and, after a year of internship, went into the army and is stationed at a missile base in North Dakota. Harold travels quite a bit and so can occasionally see his son, who is very good to him. He mentioned that, in Canada, his age gives him the benefit of two-thirds fare on C.P. airlines. In March, Harold was staying in Bellingham, Wash., where he found it pleasant and kept busy partly by reading some of the German classics; that led him to recall Professor Vogel and Mr. Blachstein, to whom many of us should be grateful for good teaching. In writing to Harold, I admitted that my own German reading is rather easier—"Das Beste aus Reader's Digest." Harold plans to be with us at our 60th; I hope he will have lots of company.

Bob Townend wrote in April that the American Institute of Chemical Engineers had established a Fellow grade of membership, and that our congratulations are due to **Ray Dinsmore** on being among the 25 M.I.T. men (out of 108 in all) elected to that grade. Bob mentioned that his own work had been more in chemistry than in chemical engineering. Referring to the account of Ray's trip to Japan in the Class news last February, Bob spoke of his and Maude's visit to that country on a round-the-world trip of the American Association of Retired Persons several years ago. He mentioned good views of Mt. Fuji from ground and air, seeing temples, parks and ceremonies, and visiting an island where cultured pearls were grown. At the latter place, a tourist, for 300 yen (then 83 cents), could choose an oyster and have the pearl it contained. Maude picked "a hoary old one and got a beautiful, perfectly spherical, pearl 5/16ths inches in diameter."

A postcard showing an attractive scene in Barbados came in March from **Fred Karns**. He and Margaret were enjoying a Caribbean cruise on the *Queen Elizabeth*.

The Alumni Records Office learned in March of the death of **Ralph E. Wells, Jr.**, in Anaheim, Calif., on April 8, 1969. The card file kept by my predecessors shows that Ralph was with us in all four years, graduated in Course III, was a lieutenant in the 65th Field Artillery, A.E.F., in 1918, and was for some years a metallurgist with American Smelting and Refining Co., in Utah and Montana. From 1922 on, he lived in California, and had resided in Anaheim since early in 1960. The file shows also that he married Charlotte Araminta Epler in 1919, and had two daughters.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Ct. 06119

15

Again The Class Supreme proved itself really supreme on April 13 at lunch at The M.I.T. Faculty Club here 23 classmates and guests gathered for a record

attendance. It's a pleasure to record the long-distance men—**Larry Bailey**, his son Bob, '48—and **Ray Delano**—Duxbury; **Wayne Bradley**—Moosup, Conn.; **Evers Burtner**—Kingston, N.H.; **Jack Dalton** and **Pop Wood**—Peterboro, N.H.; **Charlie Norton** Martha's Vineyard; **Fred Waters**—Marblehead; **Max Woythaler**—Framingham; and the winner—**Ben Neal** from Lockport, N.Y. Also present were **Dinger Doane, David Hamburg, Clive Lacy, Horatio Lamson, Azel Mack, Archie Morrison, Harry Murphy** and his son Peter, **Wally Pike, The Pirate** and his son Gerry and **Bill Sheils**. It's remarkable that this record lunch attendance includes five sons of classmates, who add a lot to our party and are always welcome. Also *all* class officers were present.

Notes of regret from those unable to attend attest to their interest—**Sam Berke, Alton** (The Wolf) **Cook, Whit Brown, John Dalton** (just back from Florida), **Larry Landers, Boots Malone** and **Stan Osborn, Louie Young**. Some day they'll come and we'll break all our attendance records. It was a pleasure to have President Jerry Weisner drop in to see us and shake hands all around. All in all, a fine bunch of old friends. The Pirate in fine form opened the meeting with his lusty and nostalgic "we are happy." An hour of cocktails and a good lunch put us in a good mood to hear our Class President, Jack Dalton, close the meeting with a tribute to the class loyalty and spirit, especially the sons who attend regularly. Next class lunch in October: Meantime, the annual class cocktail party and dinner will be held on Monday June 4 at the M.I.T. Faculty Club at 4 p.m. See you there!

Our **Mary Plummer Rice** keeps going gayly. In March she attended the Twenty-Fifth annual anniversary of the Mexican Fiesta given by the Mexico City Chapter of the Alumni Association, only one other co-ed attended. From the souvenirs and folders she sent me it must have been very gay and interesting for Mary. . . . Although he was disappointed that he did not make full professor in Naval Architecture while teaching at M.I.T., **Evers Burtner** was made an Honorary Member of the Southern Naval Architects and Marine Engineers and of the Eastern Yacht Club at Marblehead—one of the top clubs here. He wrote the Marine Engineering Chapter in the famous Marks *Mechanical Engineers Handbook*. . . . **Ellis Ellicott** keeps in good health at 81 and in April attended his 60th Reunion from Johns Hopkins in 1913. . . . **Orton Camp** and his wife spent the winter at Siesta Key, Fla., but hated to leave the good weather in Connecticut. He is in good health! . . . **Vik Enibuske** has been in the Mass. General Hospital for some time, with what he fears may be Parkinson's disease. . . . **Henry Leeb** continues to hibernate comfortably at his guernsey farm, Walnut Hill Farm, Gladstone, N.J., and invites any classmates who are peregrinating his way. Many of these colorful and interesting notes from widely scattered classmates are excerpts from letters **Ben Neal** gets in answer to his "soft sell" appeals for the Alumni Fund. Ben has done a magnificent job for our Class on this. He wrote, "the class lunch was a nice party and as usual, it was a pleasure to see the 'old gang' ". . . . **Charlie Norton** and Ben stayed over with me—always pleasant and welcome guests. . . . **Ed Walker's** daughter, Mrs. Marion W. Harding of Batavia, N.Y., sent us a reprint of her ad in *The Christian Science Monitor* thanking that paper for an ad it ran 45 years ago that did a lot for Ed's famous company Kozak Manufacturers of automobile cleaning and polishing materials.

Maurice Brandt, died January 10, in Salsbury, N.C. Maurice was a regular and generous supporter of all Class and Alumni affairs and always attended our five-year Reunions. . . . **Harold Pickering** died February 19, in Ithaca, N.Y. Pick had conducted a heating engineering business there for a long time.

We hope to see many of you, your families and your guests—all welcome at our Annual Class Cocktail Party and Dinner, 4 p.m., Monday June 4 at the M.I.T. Faculty Club, 50 Memorial Dr., Cambridge.—**Azel Mack**, Secretary, 100 Memorial Dr., Apt. 26A, Cambridge, Mass.

16

It's here—our 57th Reunion on Tuesday, Wednesday and Thursday, June 5, 6 and 7 following Alumni Day on June 4. "We'll celebrate and how we'll eat again" says our genial president, **Ralph Fletcher**, "at the delightful Chatham Bars Inn on the Cape in Chatham. Don't miss this one and come early if you can—enjoy the deep blue sea, the invigorating salt breezes, the shore dinner and the ever-bubbling enthusiasm of the young-at-heart." And for those who can't make the Cape, there'll be a Mini Reunion at Tech on Sunday June 3, 5:00 to 6:00 p.m., as indicated in recent issues of the *Review*.

We now mention **Izzy Richmond**, not this time as a soaring explorer of the high clouds over Nantucket, but as the center of attention of an event covered by the following invitation we received early in April: "Reception: In honor of its first anniversary, the Westbrook Village Office of the Union Warren Savings Bank proudly invites you to the first showing of its permanent public exhibit, pencil paintings of religious edifices in West Roxbury and Chestnut Hill by Isidor Richmond, F.A.I.A. Sunday April 8." And Dave Patten also sent us a clipping of an article in the April 8 issue of the Sunday *Boston Herald*, that told about it under the heading, "Noted architect's 'pencil' paintings on exhibit." The article went on to say, "A Fellow of the American Institute of Architects, Richmond was awarded the Harleston Parker Gold Medal by the Boston Society of Architects of which he is a past president, and he was also a recipient of the A.I.A. Award of Merit. Richmond, who is a past president of the Boston Architectural Center, will be present to sign prints for guests. Framed prints will also be given to representatives of the Temple and churches in the exhibit—Saint Theresa's, West Roxbury, the Church of the Redeemer, and Temple Emeth, Chestnut Hill."

We were glad to hear in March that Sylvia and **Vertrees Young** of Bogalusa, La., are getting back into some of the activities they had to put aside for a while. Vert says, "My new artificial hip is fine. When boarding a plane I carry a card to show that I haven't got a submachine gun in my right leg." Sylvia was about to "entertain for lunch" the annual Dogwood Queen and her court of 12, plus eight ladies—21 in all. For this event Vert said his department "has been to clean up the grounds and I must say they look pretty good. The loss of pine trees (Hurricane Camille) has let the sun in on the azaleas and the place is really lovely, with dogwoods and wisteria also in bloom." . . . Dolly and **Len Stone** took their customary three weeks in March on Young's Island just off the shore of St. Vincent, way down near the end of the West Indies. We asked him on his flight down to watch particularly for the Tropic of Cancer when he flew over it. We mentioned to him that in our aged Hammond Atlas it is a white line on a blue background. But Len reported back that the Tropic of Cancer was a red line on a white background. How things have changed! . . . Back in December, **Ted Parsons** of Phoenixville, Pa., wrote of plans to move to the town of Thetford Hall, Vt., where his son-in-law has purchased a small business, after his early retirement from a large company. "We have all wanted at some time to retire to Vermont, and now is the time! The move will come about the first of March and we are now working to sort out and discard the accumulation of years, in favor of life as it will be." . . . From St. Louis came word in February from **Berthoud Boulton** who has been enjoying his volunteer teaching of basic math. As a hobby he enjoys wood turning of bowls and such and "over the years I have made scores of toys for our Head Start kids in St. Louis."

Hank Smith in Leisure Village, Lakewood, N.J., reported some time ago that he had hoped to write that his wife, Dot, had returned home, but she passed away early in 1972. "Although living alone is not too much fun, I am quite comfortable on the lake here." . . . In Oswego, **Charlie Glann** says it is with great thankfulness he cay say he is on his feet. "I don't walk out doors much but nearly every day Helen and I get out for a ride. We mostly take secondary roads as we can enjoy the countryside. Even though we often cover the same territory, the scenery changes with the seasons. We particularly enjoy the spring with its encouragement of new life." . . . **Dave Patten** tells about the five weeks he and Dorothy had in California back in January and February including a stay for treatments in La Vina Respiratory Hospital in Altadena. "Outside our window Mount Wilson of observatory fame rose to 5000 feet, and at lower levels the deer and coyotes played hide and seek. I made frequent trips to nearby Huntington Memorial Hospital for all manner of tests, from which I emerged unscathed. A winter of bountiful rain has made California a garden spot and the beautiful acres surrounding the Huntington Museum were beyond description. Later, from San Diego our

tracks led to Monterey and Carmel, where there's a charming little place, Pine Inn, which I can highly recommend. Our last Sunday evening was spent at Trader Vic's in San Francisco with Dorothy's brother and family, and the next night we were having supper at our fireside in Duxbury. Such is the magic of TWA's flying carpet!" That's the second time recently we have heard of Trader Vic's, the last time with highest enthusiasm from **Paul Austin**. . . . And from **Don Webster** came word that he and Nell were tickling their toes in Siesta Key's powdery sand in Sarasota. . . . And **Ed Hall** wrote in March that at the end of the month they were leaving their place in Marathon, Fla., for good as they had sold it. Said they were sailing on the Santa Maria out of Port Everglades for Portugal and returning—about 27 days with three at Praia de Roche on the southern coast of Portugal. "Next year," he says, "we can go where we wish for the winter from Baltimore."

We can say "Hear, hear" to what **Clint Carpenter** of Virginia Beach, Va., had to say in March: "It is gratifying to realize that despite our many diverse interests, the common bond of friendship as 'Sixteeners' never fades!" He went on to say that "the traditional winds are trying desperately to discourage the spring flowers but the daffodils are just as courageous in a much nicer way, and are even now beginning to say: "I told you so!" . . . Also in March, we had word via **Jim Evans** from **Jack Burbank** who was "improving day by day and out walking when the weather was warm and pleasant," and from **John Fairfield** who told of the weekend visit of his daughter and family including two grandsons: "A jolly visit; we went to see the New York State Capitol and the infamous million-dollar staircase. What prodigals these politicians!"

At the annual meeting of the American Society for Quality Control in May, your Secretary was honored with the 1972 E. L. Grant Award for his "outstanding contributions to the advancement of quality control educational programs." Among other things was cited his work with Army Ordnance during World War II, in the development of new Ordnance sampling inspection tables used throughout the war, and their implementation in 31 quality control training conferences across the country.

We regret to report the death of **Bradford Curtis** of Interlaken, N.J., in March. He died in his sleep of a heart ailment after a short stay in the hospital. Professionally his work was in public utility engineering with his greatest interest in design of substations and lines. As he said in his notes for the Class History at the time of our 50th Reunion, extracurricula-wise, Boy Scout work and sailing meant the most to him. After retirement in 1956, he became an instructor in electrical engineering for seven years at Newark College of Engineering.

Finally, once again, all the old-timers hope to see you at Chatham Bars Inn for the 57th. Have a good summer. Just keep your glad-to-hear-from-you Secretaries from getting lazy. Write a little but write often, a bit of mature philosophy if you are not doing too much.—**Harold F. Dodge**, Secretary, 96 Briarcliff Rd., Mtn. Lakes, N.J. 07046; **Leonard Stone**, Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

17

Dud Bell's acupuncture experience has attracted considerable interest so it is good to have further word from him. He writes: "I have delayed writing because I wanted to know just how much improvement would show with acupuncture going along with monthly treatments. Last Wednesday (April 18) I went to New York for the fourth treatment. This time it was much prolonged and the needles were inserted in each leg for some 30 minutes—one above and one below each knee. Then the needles were inserted in my back afterwards, one in each upper part below the shoulder joints. About 30 minutes of this treatment concluded everything. The vibration battery was used throughout it all. The pains I experienced were slight although the needles in my back were felt in the toes of my feet. It is too early to say that I am fully recovered from the deterioration in my legs and around my ankles but I believe that my hopes for getting rid of present troubles are pretty good." . . . I have received a letter from **Bob Erb** who has an "arthritic neck" and is checking into acupuncture so I am sending along to him all the information I can. Acupuncture has been outlawed in New York but is likely to be legalized soon. Meanwhile I have been fortunate to have a responsible M.D. who is well up on acupuncture and is quietly treating a few patients."

Stan Lane has made good his threat to retire from his Lane Brothers Co., shoe manufacturers and importers. This interrupts an unusual schedule that he has followed for years. Each weekday morning found Stan at his office by 7:30. Like as not the day's work would be done, these later years, by 9:30 to 10, after which he would occupy himself at home or about his numerous outside interests. Now he will spend time with his Wellesley flower garden and more time at his lakeside place in New Hampshire. Fortunately he has not retired as our Class Treasurer.

The **Bob Erbs** enjoyed time in Jamaica and both coasts of Florida. He was a guest of Whittemore Brown, '15, at the March meeting of the Sarasota-Bradenton M.I.T. Club at the Sarasota University Club. Ray Ellis '22 gave a very interesting talk on Russia which he visits frequently. Bob was glad to meet classmates **Vincent Panettiere** and **Harry Wansker**, both now Sarasota residents and club members.

The 25th M.I.T. Fiesta in Mexico was a sparkling affair. It surpassed all previous Fiestas in attendance, stimulated by the presence of 65 members of the Class of 1931. Our Class had its usual compliment of the faithful, Conchita, Ruth and **Bill Dennen** and **Al Lunn** as well as honorary members, the Johnsons and Severances. The program was excellent and the Noche Mexicana in the beautiful garden of Luisa and Nish Cornish was the real highlight of the affair. The Fiesta is recommended to our classmates and it is hoped that more will attend in the future.

Make your plans now to attend our 1973 Interim Reunion October 10-11-12 at the attractive Northfield Inn, Northfield, Mass.

With regret the deaths are recorded of **Arthur Carter** at Cranston, Rhode Island on February 20 and **William Haines** on October 14, 1968.—**Stanley C. Dunning**, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard**, Assistant Secretary, 21 East 87th St., New York, N.Y. 10018

18

Sometimes, something happens which is so heartwarming that you feel lifted with a tingling joy. Such is the situation which I now record with respect to our most modest Class President. It seems that the Amesbury Metal Products Co., of which he has been the guiding genius and active head, was ordered by its principal stockholders to cease business and to be auctioned off piece by piece. The following editorial from the *Newburyport Daily News* of April 9, tells the story. All of us join in congratulating Amesbury on having John as a leading citizen and in wishing him well on the rebirth of the enterprise which he had built up so well over the years. The article is titled "Happy rebirth of an old company."

"Faith and determination are reflected in the successful efforts of **John W. Kilduff**, head of the Amesbury Metal Products Co., to keep the 40-year-old concern alive by finding a proprietary corporation, Russell Kendall of Delaware, to take it over.

"At a time of life when most men would be contemplating retirement, this staunch industrialist, who has witnessed both good and hard times in his home town, resolved to explore every means of maintaining the operation. As a result, Amesbury Metal will not only survive; it will be expanded amid improved facilities.

"Especially good news for Amesbury is that John Kilduff will remain as manager of the operation, affording employees an atmosphere of confidence and security. The new chapter for Amesbury Metal has much in common with its first chapter. Principal founder of the concern was the late John J. (June) O'Brien, who had played prominent roles in the auto body building business in its prime. In the depression '30s, the picture was bleak and becoming more discouraging daily.

"Then—on a Thursday deeply graven in the memory of newsmen of the time, "June" made the announcement that a new industry was being born in a one-time auto body plant. As a symbol of courage and hope, O'Brien had the plant's steam whistle reactivated and for the first time in years Carriage Hill re-echoed to its compelling signal, "Come to work, men!" The new venture, materializing at a time when old ventures had become history, had a galvanic effect upon the people of down-trodden and apprehensive Amesbury.

"Good luck to John Kilduff and Amesbury Metal! Not only is the fact of its rebirth cheering news; especially so is the hardy human spirit which has brought it

about."

Thanks to our enterprising and industrious Len Levine, we have a number of very interesting replies to the many letters from his pen. The first is from **Stuart Elliott.** "In writing of highlights of my perhaps somewhat colorful but not distinguished career, I have plenty of high spots but they do not involve board meetings, literary prizes, scientific acclaim, nor the usual earmarks of the worthy and successful. I am not even one of the so called 'beautiful people' whatever they are but I have seen a few things in different parts of the world, have had some articles published. One of these, in the magazine of the New York Museum of Natural History. I have kept solvent and out of jail, have married a very glamorous girl and kept married. I now have a book on the first World War in the hands of an agent. It has a praisefull foreword by General George C. Kenney, who was General MacArthur's Chief of Aviation in World War II.

"As to Keneysians and that ilk, I readily understood math through differential equations and I can make sense out of Einstein and the fourth dimension, but the more I read about the theories of the general run of economists. I am as much in the dark, as if I were scanning some stone inscription by the ancient Hittites.

"I had two years at M.I.T., but left in the spring of 1917 to join the air force. My great regret is that I did not return to it after the war, and get my degree from it."

The next note is from **John Gustaveson:** "Dear Len, I am sorry that I do not recall you—I was Course VI, starting in the junior class and leaving M.I.T. in March, 1918 to enter the service after completing all lab work and thesis. Also being from out of state and with rather limited funds, I did not participate in much of the class activities so did not get to know very many fellow students.

"I went overseas with the 50th Artillery C.A.C. and when the Kaiser learned that we had landed in France the latter part of October, he decided to sign the Armistice. Mrs. Gustaveson and I celebrated our 54th Anniversary in February and on January 1, our first great-grandson was born. My career included Westinghouse Electric, Kansas City, P. and L. Co., my own company designing and manufacturing power switchboards, switchgear and control panels, and the last eight years with Black and Veatch Consulting Engineers here in Missouri. I retired last Thanksgiving and am enjoying my leisure very much—including my great-grandson."

A letter via Len, from **Bob Rowe**, follows: "I retired in 1960, but have been just as busy, active, happy and healthy trying to keep from earning another nickel. Mainly, this no-nickel objective has been well served by hobbies for writing and mathematical recreations.

"I had conducted a column in *Civil Engineering* since 1940 and kept this up until I had rounded out 25 years (and 300 columns) in 1965. I have continued contributing technical papers to journals of the American Society of Civil Engineers.

"The 'column' followed a theme of mathematical recreation, more or less related to engineering problems. For the last 6 years I have been a fairly regular contributor to Gottlieb's "Puzzle Corner" section of *Technology Review* and to the Journal of *Recreational Mathematics.* I enjoy solving problems posed by others and composing some of my own invention—and even just plain doodling with figures.

"What keeps me busiest is leading a 'double life'. I have a second home on the north shore of Lake Michigan, where I reside from mid-April to mid-October. It is within the 35000-acre domain of the Hiawatha Sportsman's Club at Naubinway, Mich. As a member of its Planning Committee, I have mapped the more intensively developed 10,000 acres for land-use zoning. I am serving on its House-and-Grounds and Historical Committees. Also, one group of the Club is the Hiawatha Nature Study Society which schedules activities twice a week all summer and maintains a very fine national history museum. I take part in both programming and leading these activities, conduct a nature walk every Sunday, and maintain one room of the museum. I have had to become something of a botanist, silviculturist, limnologist and ecologist, for the domain is part of the Upper Peninsula's post-glacial forest-and-lake terrain.

"Incidentally, I am a rail buff, so I commute by Amtrak and Canadian lines. I am hoping to find an Amtrak routing to our 55th Reunion next June—perhaps via Montreal. If so, I'll see you there. Cheerio."

Len's letter to **Harold Connett** was answered by his widow, to whom we extend our deepest sympathies. We are grateful to Mrs. Connett for telling us some of the things Harold had accomplished: "I have your letter of March 21, 1973, to my husband, Harold Connett, who died last July 14, one day before our 52nd Wedding Anniversary. We have lived here in Quoque since his retirement in 1960. After he became a gentleman of leisure, we traveled a great deal—mostly by cargo ship. In 1961, we went from Brooklyn to Singapore where we left the ship and flew to Australia, where his former employers had asked him to make a report on the aspects of the kangaroo business for the future of American tanning. We went to Sidney, Perth, Rockhampton, and visited a large sheep ranch. The owner took us on what he called a Sunday afternoon boo hunt. It was indeed a great experience.

"In 1968, Harold's health began to fail and we gave up traveling. He suffered from Parkinson's and other ailments of old age.

"Besides me, he is survived by one daughter, Mrs. Stephen A. Stack, three sons, one granddaughter, ten grandsons and two great-granddaughters. An eldest son, Harold, Jr., was killed in action in W.W. II."

Len's letter to **George Pierce** was acknowledged by his widow, who noted he had passed away on February 2, 1973. We extend our deepest sympathies to Mrs. Pierce.

We look forward to seeing the **Charles Taveners** at Chatham Bars Inn as noted in the following letter: "What is cooking on the Class Reunion? I hope we go to the Cape as usual. Rhoda and I expect to spend a few days on the Cape anyway. Have several stops on the way up to West Orange, N.J. We will also visit N.H. this summer and a week at Lake George and Ogdensburgh, N.Y.

"In the late summer, we will start for California to see Rhoda's daughter (husband Captain Coast Guard, N.A. M.I.T. post grad.) From there we will go to Japan and various countries. Are any of our Class or thereabouts still alive in Nationalist China and/or China mainland? If so, maybe I could see them again. I was a member of the Cosmopolitan Club, I believe, at one time.

"Still getting settled here because the house was 12 years old and we wanted to make some changes. Regards to the Class."

Len Levine received a letter from **Carlyle Fiske.** After an interesting career, he retired in 1953. He maintains his home in Winchester but recently built a home on Cape Cod where he and his wife spend most of the year. He extends best wishes to the Class.

We have received the following changes of address: Joseph A. Kelley, Meadowlark Dr., Tryon, N.C. 28782 and Mrs. Marion C. Kenney, 17 Main St., Hatfield, Mass. 01038—**Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass.; **Leonard Levine**, Assistant Secretary, 519 Washington St., Brookline, Mass.

19

Chuck Drew called in March from Key Biscayne, Fla., where he was spending some time on a holiday. He lost his wife several years ago. Also he mentioned that Fred Barney's widow had remarried recently.

The following letters came in March from **Will Langille:** "Dear Gene and Mr. Secretary, a question for you! Am I the first great grandfather of the great Class of 1919 of the great M.I.T.? Now something else. I have started the ball rolling for the 55th. Hope some of us will last that long besides you. You'd be too lonesome. This time I have no helper at hand but you'll be hearing more and more, so watch your mail and if you get up this way let's tip a glass and break bread. Seriously, hope this finds you as well as I hope you are."

Your Secretary will be at the Wellesley graduation in June helping my wife celebrate her 50th and hope to be at our M.I.T. Alumni Day, June 4. Have a good summer.—**E. R. Smoley**, Secretary, 50 East Rd., Delray Beach, Fla.

20

Harold Murray of 4406 Sherwood Rd., Jacksonville, Fla., comes across with some welcome news. After a long and distinguished career in naval aviation during which he saw active service in both World Wars and received a bronze star with combat, Harold retired as a Captain, U.S.N.R., some years ago and

started a new career as a real estate broker in Jacksonville. It was a real pleasure to hear from him after all these years. Another prominent Floridian is **Clyde Hall**, realtor of Osprey. Clyde is retiring this month as President of the M.I.T. Club of Southwest Florida after a two-year term. . . . **Al Wason** announces with justifiable pride the arrival of his first great granddaughter. It would be interesting to know how many of our classmates have achieved this distinction. Don't be bashful, fellows, check in with your Secretary who will duly place your name on the honor roll. Back home in Wellesley, Al visited his twin in Florida and stopped off to see his son's family in Virginia.

New addresses include **Stan Bragdon**, formerly of Fryeburg, to 322 Pine St., Lewiston, Maine. . . . **Harold Dennison**, 54 Raleigh Rd., East Weymouth, Mass. . . . **Louis Waters**, 211 Lafayette Rd. Syracuse, N.Y. . . . Captain **Fred Earle**, 6251 Old Dominion Dr., McLean, Va.

Word has been received of the death of **Edmund C. Sullivan** of 416 So. Beach Blvd., Bay St., Louis, Miss. 39520. We have no further information at this writing.

We wish you all a happy, relaxing and carefree summer. Do find the time to drop us a line.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

21

Here it is almost summer again with Alumni Day behind us and the opportunity to renew our ties with M.I.T. and the good fellowship of alumni friends. A few of you have written me in the past month, for which I am grateful. I urge others whether they owe me a letter or not, to take pen in hand.

Irving Jakobson reported a marvelous 25th Fiesta in Mexico attended by Maxine and **Cac Clarke**, Laura and **Bob Haskel**, Win and **Royal Wood**, Charlotte and **Bob Barker** and the Jakobsons. Afterwards the Clarkes and the Jakobsons went on to tour the Mayan ruins of Chichen Itza and Uxmal in the Yucatan Peninsula. On the way home, Jake and Ruth stopped in for a brief visit with Muriel and **George Owens** at Vero Beach, Fla. . . . A few additional footnotes have come in about the Mini-Reunion in Florida. A post card from **Helen St. Laurent** told of her visit to the beautiful Cypress Gardens in the company of Graciela and **Helier Rodriguez** and Ruth and Irving Jakobson. Helen was the house guest of the Rodriquezes for ten days at their apartment in Tampa where she shed some of the winter pallor of Connecticut. Helier is reported to have heaved a sigh of relief at the conclusion of the Mini-Reunion. He and his committee put in many hours of planning but everyone has rated it a "fine affair" and it will probably be repeated in years to come.

Wallace Adams of Middletown, Oh., phoned and talked to **Ollie Bardes** who hosted "in absentia" the Bardmoor Mini-Reunion. Ollie was reported to be making a good recovery and planning a number of business trips for Bardes Industries. . . . Letters from **Josh Crosby** and **Herb Kaufmann** tell of visits and cocktail parties in Sarasota including the Roy Woods and the Whittier Spauldings. One afternoon they had a big golf match and decided at the finish that they had all been going for a high score. . . . It reminded your Secretary of our 30th Reunion when one **Sumner Hayward** won a dozen M.I.T. glasses for a high gross score of 148. "Do you call that golf?" asked **Mich Bawden** disgustedly as he handed out the prize. . . . At the annual picnic of the M.I.T. Club of Southwest Florida on Casey Key, three M.I.T. '21 couples enjoyed the day: the Crosbys, the **Tom Duttons** and the **Phil Paysons**. "A beautiful spot and a nice picnic," said Josh.

William Rose, Jr., R.D.2, Peterborough, N.H. 03458 broke the silence to tell of volunteer work he performed at the local hospital. Snow to date (92 inches by March 18) was only half the usual amount for lower New Hampshire, but a lot more than the six-inch total in northern New Jersey. Bill's address above is different from the Hancock, N.H. address we had. Have you moved, Bill? . . . A postcard from **Ralph Shaw** of Beverly, N.J., mailed from Cook Islands, portrayed the S.S. *Mariposa* on a January cruise to the South Pacific. Quoting Rufe, "Madeline and I are well and happy, enjoying hot summer weather. Expect to be in Sanibel, Fla., in March." . . . **W. Hoyt Young** of Escondido, Calif., sold his ranch last year and got out of the fruit raising and poultry business. Reports Bill, "I'm busy building our new home in Escondido and spend my time in electronics, operating a sewing machine, playing an organ, studying Spanish and other hobbies that intrigue me." Bill retired from patent law practice in 1963.

With sadness, we record the deaths of two of our classmates: **Thomas P. Campbell** of Denver, Colo., on April 8, 1972 and **Harry A. Goodman** of Brookline, Mass., on March 23, 1973. Tom Campbell joined our Class in the junior year after preparation at Exeter Academy and Dartmouth College. For many years he was manager of parks in Denver. Harry Goodman entered M.I.T. in our freshman year, attended many reunions including our 50th and was a specialist in wills, trusts and estate planning. Thanks go to **George Schnitzler** for supplying information about Harry Goodman.

An April meeting of the M.I.T. Club of Northern New Jersey saw **Joe Wenick** and your scribe among those present. An excellent talk was given by Professor Margaret MacVicar whom some of you probably heard on Alumni Day, discussing M.I.T.'s undergraduate research opportunities program (U.R.O.P.) Joe continues to be active in the M.I.T. Club and was on duty receiving cash from the customers that night. He also does occasional consulting work, and related that recently he ran a plumbing company while its owner was on vacation. "I'm the only plumber in New Jersey who keeps his promises on appointments," said Joe. He was appointed a member of the Caldwell Historical Committee which is starting on plans for a celebration in 1976.

The Haywards had the pleasure of having two classmates stop by during April. Emma and **Al Lloyd** returning home from the Florida Mini-Reunion, stayed overnight after having visited their children and grandchildren in Atlanta, Ga., and Arlington, Va. Then Helen and **Bob Miller** joined us for lunch on the way to opening up their summer cottage on Cape Cod. Bob said they were sitting at home one evening recently when the phone rang. **Ed Farrand** of La Jolla, Calif., was on the line. He reported that he was feeling reasonably well, and that Maxine and **Cac Clarke** had dropped in on their way back from the Fiesta in Mexico.

Sam Lunden reports that **Cac Clarke** called his office to say that they had only one day to see the City of the Angels. Their Marineland tour brought them within a block of Sam and Leila's home in the Palos Verdes hills, so they stopped by to take in the impressive view of the Los Angeles-Long Beach Harbor from the terrace some 600 feet above the ocean.

Have a good summer!—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla., 33580; **Samuel E. Lunden**, Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

The spring flowers in Buffalo have been blooming during March and April because the normal Lake Erie ice pack coming down from Detroit and Cleveland just hasn't occurred this year. Soon we will be needing the Lake's cooling breezes to air-condition Western New York.

It was good to note that the Class of '22 was well represented at the March Council meeting of the Alumni by **Robert Brown** and **Warren Ferguson**. They now know about the "M.I.T. Burd" and will help demonstrate it or at least explain this research device at our June Reunion. . . . We have all received the announcement from president **Parke Appel** of the appointment of Margaret L. A. MacVicar as the Class of 1922 Career Development awardee. We are fortunate to be able to make this constructive contribution for the greater future of M.I.T. However, don't relax too much as our Class Agent **Dale Spoor** will always be back for more. . . . Now comes the sad part of this report: No news has come in this month. If you see big, salty tear drops on this sheet it's because your Secretary much prefers to hear from many of you and pass on interesting information to readers of our column. Help!

The sympathy of our Class is extended to the families of **Lloyd E. Raymond** of Stratford, Ct., and Dr. **M. Ewart Hurst** of Toronto, Ont. We also heard from the family of **Bennett Myers** of Dallas, Tex., who passed away in August 1968.

Our changes of address are Roger C. Bauman, Fairhope, Ala., and Clarence P. Spofford, Gardner, Mass. . . . It is now Easter Week, so off to the golf course for sun and fun. Here's hoping you are doing the same.—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203;

Oscar Horovitz, Assistant Secretary, 31 Montrose St., Newton, Mass. 02158

23

By the time you read this the great 50th Reunion of the Great Class of 1923 will be all over. While the Alumni Association pundits predicted 186 persons as being present it looks to me at this point that we will attract about 135 in all. I hope that I will be proven in error. A full summary report of the Reunion will appear in a later issue of this publication since our lead time is not as modest as that of *Time* magazine.

No further news except to report the death of **George H. Hurley** of Burlington, Wisc., on February 22, 1973. We have no further details.—**Thomas E. Rounds**, Secretary, 4 Deer Hill Dr., Danbury, Ct., 06810

24

At a record 79 degrees yesterday, April 17, I must have brought the Arizona weather with me to Brookline and will continue my recuperative period here. In Tucson, the loneliness of a house in the foothills was broken by Dorothy and **Ray Lehrer** visiting the area for a week. I am very thankful for their attention. Ray dug up one **Hood Worthington** and Martha living in a mobile home on the east side of the Catalina Mountains, via the program of the very popular "Forum," on which Hood was shown as a sponsor. They, too, are attached to the desirability of the area. Dot and Ray were returning from South America via Mexico City and I again urge those who read travelogues to ask for Ray's Xerox copies.

The Second Annual Florida Fiesta was held March 9 and 10 at Vero Beach. We are greatly indebted to **John Fitch** for a complete story. As your Secretary is pressed by the deadline, he will cut information short, but you should know who and where some of us are. . . . John and **Boynton Fletcher** followed President Nixon's austerity theory and came up with a $27.67 surplus which was voted to the 50th Reunion Fund. . . . Bubbles and **Andy Kellogg** were there. . . . **Dick Jackson** brought his old guitar and **Gordon Harvey** tickled the piano keys to make it a lively affair. I may miss a name, but those present were: Lorene and **Paul Cardinal**, Allora and **Clint Conway**, Mary and **Si Duevel**, Mary and **John Fitch**, Ruth and **Curley Fletcher**. Clare and **Gordon Harver**, Lois and **Dick Jackson**, Peg and **Pret Littlefield**, Helen and **Paul Miller**, Helen and **Dick Shea**.

Some who could not come, but are somewhere in Florida: **Harry Ferguson**, **Al Roig**, **Gordon Billard**, **John Benson Sloan** (a retired clergyman), **Janet** and **Hap Stern**, **Jay Buswell**, **Ed Keyworth**, **Reynolds Konold**, **Lloyd Porter**, **Walter Weeks**, **Tom Rhea**, **Ron Giles**, **Joe Tryon**, and **Ed Wood**.

Soliciting for such an affair always develops sad news, and it was learned that notices to **Edward R. Barnes** and Colonel **Edwin A. Smith** were returned marked "Deceased." . . . **Dana Staples** passed away in November 1972. . . . **Gordon F. Eaton**, 13302 Cormere #601, Cleveland, Oh. 44120, died March 7, 1973.

A very nice note from **Joe Young** in Los Angeles stresses the hole-in-one he made on the 13th 154-yard hole on the La Miranda course. With that he sends best wishes to all the hard-working '24 Class officers. Freda writes and sends a picture of **Nat Schooler** in the *New York Daily News* of March 29, 1973. He was honored at a dinner dance March 31 for his long-time community achievements for the United Jewish Appeal of the Borough of Queens, one of the largest communities in New York City. Six hundred guests attended and I am sure that Nat was his usual unassuming self. The Schoolers and **Paul Tishmans** had dinner and a delightful evening given by the Board of Governors of the M.I.T. Alumni Center of New York at the United Nations. They had the pleasure of meeting Kurt Waldheim, U.N. Secretary, President Wiesner and Chairman Howard Johnson.

Lastly, your scribe is most grateful for the encouraging cards and notes received from classmates while he was confined *hors de combat* in Tucson, Ariz.—**Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146

25

Sam Spiker, our energetic Class Agent, covers a lot of territory and seems to combine business with pleasure. Recently on a trip to Florida he saw **Fred Greer** and **Franklin Fricker**. He also has been arranging for a telethon which was held in April and some of you may have been contacted through this medium. This also brings up the fact that Reunion time is approaching and while this is not our big year it will give those of us who do attend an opportunity to observe how others behave on their 50th. Shortly after you receive this your Secretary and his wife will be off on an expedition to the west and north; this time chiefly north of the Arctic Circle, some places where we have been before and others new. Parts of the trip will be in reverse of those we have taken before which makes for a different viewpoint. In the fall we expect to be off for northern Europe, but more about that later. The Alumni Office keeps sending me changes in addresses which I duly record. I note that more and more of us seem to be moving into what appear to be retirement havens.

Spencer W. Prentiss, for whom the last address I have is Worcester, Mass., passed on, December 20, 1972.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St., Cambridge, Mass. 02138

26

For the first time since last fall we are able to sit on the terrace overlooking the sea and work on Class Notes. The sea is placid but there is just enough wind to cause us to look for a small stone to keep our clippings and letters from blowing off an adjacent chair. A buoy about a mile off shore is being rocked sufficiently to ring its bells continuously and the tide is full. It is too early for our sailboat to be overboard but if it were, the conditions are perfect for a comfortable, lazy, mid-day sail. The quiet but alive sea reminds us that several friends, some M.I.T. Alumni, have had their ashes spread upon this sea which gives it added reverence.

Having worked around the subject we will tell you about some classmates who we have recently learned are no longer with us. Letters from **Ken Lord** and from **Howard Humphrey** enclosed clippings telling of the death of **James Q. DuPont**. Jim was 70 and had retired from the duPont Co., at 65. Since retirement he had been active in many charities. He was a member of the M.I.T. Club of Delaware Valley and is survived by his wife, Helen and two sons and two daughters. . . . Mrs. Gostanian has sent us a clipping telling of the death of her husband, **Gostan Gostanian** who was also 70 and retired from the New York State Gas and Electric Co. In his retirement years, Gostan had been active in the Power Squadron. In addition to his wife, Gostan left a son and two daughters.

A letter from **Charlie McCulloch** tells of the final obituary we have to report. Charlie's letter goes, "The clipping about Ed Gohr is from the *New York Times*, March 17. You will probably remember that Ed Gohr and **Jim Offut** were roommates for several years in the dorm. Although Ed was most successful in business and professionally, he never changed from the quiet unassuming and modest chap whom we knew in 1926. It was my privilege to have seen him on frequent occasions during his lifetime and he will be missed by all of us who knew him." The clipping reads as follows: "**Edwin J. Gohr**, a pioneer in petroleum-process research and a former vice president and director of the Esso Research and Engineering Co., died March 9 in Lenox Hill Hospital. He was 70 years old and lived at 785 Park Avenue. Mr. Gohr was involved in the development of fluid catalytic cracking, the most widely used process for producing high quality gasoline. He had been with the company for 40 years. He leaves his widow, the former Polly McIntyre."

Needless to say this issue of Class Notes has not been the kind we like to write. I know that all of you will join me in extending the sincere sympathy of the Class to the families of these classmates.

It is not as warm on the terrace as when we started and the gentle breeze has developed into a firm and steady southeaster but by donning a Harris tweed jacket it still remains comfortable here in the sun. We have taken time out to heat up a bowl of Bouillabaisse which is the only dish your Secretary ever prepares. It is a French fish soup and we found the recipe on page 60 of the *Good Housekeeping Cook Book*. We use a broth as a base made by simmering lobster bodies. When seasoned, this broth is used for cooking up any kind of fresh fish.

Now for a final announcement from Class President **Dave Shepard**. **Thornton W. "Mooney" Owen** has agreed to take over the responsibility of Reunion Gift Chairman for our 50th in 1976. He replaces **Austin Kelly** who has led our ef-

fort superbly to date, but who has sufficient other M.I.T. interests that he felt another classmate should take his place. More on it as soon as he and Dave and members of the Alumni Association staff get together in Washington in a few weeks. And until then—Cheerio!—**George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

All of us by now have faced major or minor catastrophes, and fought through them with more or less success. But very few of us have had to surmount such odds as **Ted Ordman** has battled and overcome. I find Ted's "profile in courage" intensely moving, and I am going to devote most of this month's notes to it.

Ted was barely five years out of M.I.T., in the summer of 1932, when a bout of septicemia, "brought on, " Ted says, "by the unauthorized and officious meddling of an intern," caused him to lose his hearing completely. An aftermath of the septicemia was chronic osteomyelitis, which kept him substantially totally disabled for the next five years.

Here is the sequel, in Ted's own words: "Paradoxically, the loss of hearing resulted in my meeting many interesting people in the world of deafness, including three most important teachers of lipreading who taught me the art and fitted me to re-enter the lists of combat with the hearing world and to resume the uphill hegira from then (1937) to date. One of them, Kathryn, became my wife in 1940, and for 31 years helped and inspired me to circumvent the numerous detours and blockages on the road up." (Ted's wife died a few months before our 45th Reunion, and he was understandably in no mood to attend.)

"To be sure," Ted goes on, "competition with the normally hearing was strenuous, particularly in the field of patent law for which M.I.T., George Washington Law, and Fordham Law, as well as practical experience in the patent office itself—all, fortunately prior to the incurrence of total deafness—had fitted me. However, a stroke of luck, together with my lip-reading, enabled me to gain a new foothold in this field in 1937. I was taken 'on an experimental basis' by the senior three of the group of liberal-minded patent lawyers of what is now the firm of Kenyon and Kenyon, Reilly, Carr and Chapin. They, as well as I, realized that much of the work involved was done mainly via correspondence with clients and the patent office. In such cases, ability to hear was a negligible factor. The 'experimental basis' became a permanent one shortly thereafter, and all my working life since 1937 has been with the present firm and its predecessor firms.

"To be sure, problems did arise. Telephonic communication could not occur because of my inability to hear. But this difficulty was solved by providing me with a secretary whose lips I could read and the installation of two phones in tandem in my office. Thus, when called on the phone, my secretary on one phone would serve as my ears and orally repeat to me the message or request of the calling party and I, reading her lips, would respond via the second phone. Moreover, as I gained in experience and confidence in my ability to handle the work, I was encouraged to and did undertake oral interviews with clients and Patent Office officials (usually on a one-to-one basis. I did find that if a conference involved more than me and one other person, I could not follow, and I arranged whenever possible to limit them to me and one other.) I found people quite tolerant of this situation and often going out of their way to assist in my comprehension of what was said by resorting to brief written notes or key words on a pad I always carried with me. In the past 25 years, much of my work has involved dealing with French and other foreign attorneys and inventors, mostly by correspondence. But I have made numerous trips abroad on firm business matters and always have found a welcome there with intense efforts on the part of these people to assist me when the need arose. On occasion, too, I have argued appeals before Patent Office officials, and in some instances have been able to avoid answering embarassing questions regarding the matter at hand either by ignoring them or pleading inability to understand the questions directed at me. Sometimes this strategy has proved helpful!

"So you see I have climbed to the top" (of the listing of associates on the firm letterhead). "There were set-backs certainly during the years, but the steadfast loyalty and encouragement afforded me by my very devoted wife during all periods of despair kept me doggedly on the chosen way.

"I see in the Class Notes that many of our classmates have retired or are contemplating such a step. Although my present age would permit me to do the same, I cannot see myself reduced to such a state and am determined, since my work continues highly interesting, to keep at it and 'die with my boots on.'

"It is reasonable to assume that when 1977 rolls around, some at least of the Class will have hearing defects requiring at least the use of a hearing aid. Thus, when our 50th Reunion comes to hand, they and I will have some common experiences to discuss and share. I look forward to the event and hope to be there." I know I speak for all the Class in saying we look forward to seeing Ted at the 50th.

A note from **Bob Wallace** chiding me (gently, but justly) for my delay in returning his slides of the 45th Reunion, tells me that he was planning to leave soon for the International Rotary Convention in Switzerland.

It is my sad duty to report the loss of two more members of the Class. **Meyer G. Gorfinkle** died on February 13, at Marblehead, Mass., where he had lived many years. For a long time, he was affiliated with the Contract Administration Services of the Department of Defense. His son, Michael, '62, is an M.I.T. graduate. . . . **Alanson W. Olmsted**, who was affiliated with our Class although he had completed his undergraduate work elsewhere, died in April, 1972. He had spent many years with the American Can Co., in the Commodity Purchasing Department before his retirement several years ago.—**Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N. Y. 10583

28

When you read these notes our reunion will be history. However, as of this writing, it is still five weeks before the event. Already 140 people have sent in reservations. This is an astounding response and, while most gratifying, may result in straining the capacity of Bald Peak Colony Club. It now appears that we could even have an overflow of registrants. To our knowledge, no other Class has had this experience here before. Of course, everyone will be accommodated in one way or another. The outcome of this unexpected development will be reported to you later.

A rapid scan of the questionnaire returns tells us that most of your classmates are now retired or partly so. In general, classmates are still happily married and have an average of 1.5 children and 2.5 grandchildren. So far a total of only two great-grandchildren has been indicated for the entire Class with one more in prospect.

We have had a verbal report from **Herm Swartz** who, with wife Dorothy, attended the Fiesta in Mexico City celebrating the 25th anniversary of the M.I.T. Club of Mexico. Also attending were Peggy and **George Mangurian**, Anne and **George Palo**, and Madeline and **Hal Porter**. The Fiesta was a tremendous success. The Swartzes and Porters later joined a group on a tour to Mérida in the Yucatan where they spent several days visiting ruins and pyramids. Then Dorothy and Herm went to Winter Haven, Fla., for some additional vacation and a chance to see the Red Sox in training. Madeline and Hal finished their stay in Mexico with several days at a fishing village on the West Coast. The Mangurians went on to the Caribbean for a few weeks of vacation.

Most of the news this month is taken from reunion correspondence and the Class directory questionnaire forms that were returned. **Tom Wood**, writing to **Jim Donovan**, says he will not be able to be at Bald Peak—he simply has too much to do during that period. Like many other residents of Corning, N.Y., Tom put much volunteer effort into flood relief work following the disaster of last June. The Woods recently enjoyed a lengthy trip to the Canary and Madeira Islands, Portugal (mostly the Algarve) and Southern Ireland where Tom says the food was excellent. . . . Again to Jim is a note from **Don Fraser** who, writing from Holmes Beach, Fla., says they are beginning to suffer from pollution problems that are brought on by real estate developments. . . . In April, **Ed Poitras** wrote to say that he was about to visit Japan and had arranged to meet with **Shikao Ikehara** in Tokyo. This was a business trip on behalf of Ed's company, Fenwal, Inc. Ed also said that he and wife Pat had spent some time last winter at Vero Beach, Fla. with Evelyn and **Jim St. Louis**. Evelyn is Ed's sister. Jim has retired from General Electric Co., where he was General Manager

"Consumerism is an easy tag . . . to cover all the errors that may crop up in the business system, . . . a form of warfare." But it's also true, says Elisha Gray II, '28, Chairman of the Council of Better Business Bureaus, Inc., that "you're not going to fool the consumer for more than a moment, and you certainly aren't going to do it twice."

How to Build Consumer Confidence? Bit by Little Bit

"You can't persuade a person to believe in the integrity, strength and importance of business if he just got shafted in some transaction. . . . A prerequisite to public confidence in the business system is consumer confidence in the marketplace."

That forceful truism comes from Elisha Gray II, '28, former Chairman and Chief Executive Officer of Whirlpool Corp., who now spends one day of each week in New York as unpaid Chairman of the Council of Better Business Bureaus, Inc. He admits that consumerism—which is basically the movement to be served by the thousands of better business bureaus throughout the U.S.—isn't new. But there's an important change:

"Today the public's expectations of business are at an all-time high," Mr. Gray told du Pont's *Context* magazine in an interview published this spring. Why? Because business wouldn't have it any other way. "By our very accomplishments we have encouraged consumers to expect miracles as routine."

But maybe salesmen have gone too far. Here are some additional excerpts from the *Context* interview:

"In their enthusiasm to sell, some businessmen promise more than they can deliver, and all businessmen suffer because of it. In addition, the consumer has no way of putting his market problems in perspective. Business hasn't communicated the fact that there are billions of business transactions daily and 99 per cent of them are handled perfectly. Even a 99 per cent satisfied population leaves several million dissatisfied people and is cold comfort to the lady whose monthly bill has been mixed up by a department store computer, or who is sent the wrong article, or who received the right article only to find that it had been broken in shipment.

"The reason the business story has failed to be accepted by the public is because the public isn't listening. Consumers are so fired up about the inadequacies of the marketplace that they tune us out."

Part of the problem, as Gray sees it, is the immensity of today's marketplace.

"To serve the demands of our increasing population, we have geared our business operations to mass numbers. In my own company alone, we talk about scheduling 40,000 major appliances a day, and our purchasing people are buying on these scales. It's difficult to suddenly switch gears and think about one woman who is hopping mad because her refrigerator doesn't work. And yet, she's right—it doesn't work, and she couldn't care less about our mass numbers.

"Some consumer activists are pushing for laws that would force business to produce things that many consumers don't even want. When regulations are passed telling you how many models or what sizes of a certain product you can sell, then you are changing the basic rules of the free enterprise system. And that's what some people would like to see happen.

"Many of today's consumer wants stem from vital needs, and it's our job to show initiative in filling them. Consumers need business and business needs consumers. They're asking: What have you done for me lately? It's time business began telling them."

of the Special Lamps Works in Cleveland, Oh. . . . Helen (Mrs. **William D.) Birch** tells us that she is active as a fifth-grade school teacher in Boonton, N.J. Her other main interest is visiting her daughter, three sons, and seven grandchildren. During the summer she spends her time at Cape Cod, Mass., and in Maine. . . . **Henry Conroy**, though retired, still provides some service to the University of Newfoundland as a consultant on building projects. He plays golf at every opportunity and estimates that he has walked about 35,000 miles on golf courses in his lifetime. In the winter he enjoys curling on occasion. . . . Having retired from Eastman Kodak Co., in 1970, **Ralph Evans** is now writing a technical treatise on *Perception of Color.* This book will complement his three earlier publications: "An Introduction to Color," *Principles of Color Photography (*with Hanson and Brewer), and *Eye, Film and Camera in Color Photograph*y (all J. Wiley and Sons).

Now semi-retired, **Arthur Hall** is busy with photography, astronomy and magic. He is secretary of the Boston Assembly of Society of American Magicians. . . . **Ray Jack** writes that he has been happily married to the same girl (Lucille) for 34 years. You will recall that Ray was our champion pole vaulter. Now he is coaching pole vaulters on the Wood River High track squad in his home town. Techniques are still the same, he reports, except for the introduction of the fiberglass pole. . . . **Eleanor Pepper**, one of several coeds, writes that she has her own office as a design consultant and has membership in various professional groups including: American Institute of Architects, National Society of Interior Designers and Architectural League of New York. She is a professor at New York Institute of Technology, New York School of Interior Design and lecturer to many organizations. . . . As a consulting meteorologist, **Paul Ruch** is busy with long-range weather forecasting and research. His hobby is restoring antique motorcycles.

Lucien von Schilling, though retired, still serves on a few corporate boards and stays active in Rotary and yacht clubs. He tries hard to stay well but admits to something less than full success. His hobbies are boating and do-it-yourself mechanical work. He hopes to do some traveling before the dollar shrinks much further. . . . We learn from **Charles Topping** that his work status is that of Borough Manager for Swarthmore, Pa. He enjoys working on civic improvements both on and off the job. He is a longtime member of the Committee on Science and the Arts of the Franklin Institute. His hobbies include photography, etching, and gardening both outdoors and in his greenhouse. Last year the Toppings spent September in England and Scotland.

Now, with regret, we must report the deaths of two classmates. **Grandison Gardner** died January 19, 1973. He received his master's in Course XVIII and was a retired major general in the U.S. Air Force. His last address was in Phoenix, Ariz. We extend our sympathy to his family.

Melvin Sack died April 16, 1973 in

Austin, Texas. Formerly his home was in Louisville, Ky., where he was Manager of the Heat Exchange Department of Henry Vogt Co. Our sympathy goes to his wife Rose and her family.—**Walter J. Smith**, Secretary, 209 Waverly St., Arlington, Mass. 02174

29

James C. Reddig has just retired from Eastman Kodak after 33 years of service. He and his wife Geraldine took a European trip with the American Aviation Historical Society, visiting air shows and inspecting some of the more important collections of aircraft in museums and flying collections. They saw the Apollo XVII Launch from a Caribbean cruise ship offshore last December followed by a visit to the radio telescope at Arecibo. They also visited their grandchildren in Texas and their son who is a Captain at the Air Force Academy in Colorado. They plan to continue living in their present home.

Adrian Clark writes, "Enjoying the countryside in Litchfield Hills. Doing a little consulting, playing as much golf as possible and pick up the violin now and then. We are in excellent location to receive F.M. broadcast of good music, and in the summer we go to Tanglewood. I hear regularly from Al Hall, '27, and **Bill Bowie**." . . . **Jackson H. Emery** of Wolfeboro, N.H. is a director of Libby Museum which is open during the summer, from the last week of June to Labor Day. M.I.T. men and women are quite welcome to visit the interesting exhibits with their grandchildren. The Museum is not far from the Bald Peak Country Club, which is on the same road (Route 109). His wife Ginnie has just retired from teaching grade school in Wolfboro. The Emerys have two children and five grandchildren.

Isidore Winer sends greetings to all his classmates. He is enjoying his retirement by living a quiet relaxed life. He and his wife are in best of health and they have 3 children and one grandchild so far. . . . **Roger A. Sykes** of Bethlehem, Pa., has just completed a chalet at Lake Sunapee in New Hampshire where he and his wife Mary spend their summers. "Have continued some of my activities," he continues, "on professional and technical committees in the frequency control and selection field. Recently, I became interested in solid state synthesizers and now, after nearly 40 years of developing quartz crystals, I am learning how to get along with only a few of them instead of many." Roger received the M. J. Kelly field award from the I.E.E.E. this past year. The Sykes are thoroughly enjoying their retirement years and they are sending their regards to all.

Fred S. Eastman of Walnut Creek, Calif., retired in 1970. His wife Mary, who was with him during undergraduate years, passed away in May, 1971. She had been suffering from cancer. Fred has remarried since to his former wife's sister-in-law who lost her husband much the same way. "Since our marriage," he concludes, "we have toured the States visiting friends and relatives. We have sold our home in Kirkland, Wash., and have settled at Rossmoor Leisure World living in complete relaxation."

Harold M. Weddle, writes, "Thanks for the birthday card. After my retirement in 1970 with 41 years of service with Dewey and Almy Chemical Co., we came to the conclusion that there must be a better place than the Chicago area for all-year decent weather. With considerable research, we finally took the big step last October and moved to San Diego, Calif. Now after five months of living here, we believe it was a wise decision. Beautiful weather all year 'round, golf, and lots of interesting things to do."

Franklin P. Nicholson, writes, "I retired last year at the age of 74. I was about ten years older than most Twenty-Niners because of an aircraft injury in 1918 in France. I am not as mobile as in the past, but much more fortunate than many others. Both my wife and I enjoy good health, and swimming in the warm waters of the Gulf has brought back the use of my bad leg to the point where I use my cane occasionally. We burnt our bridges in Vermont last year and moved to Florida for good as the cold weather up north put my leg out of use. I am one of those fortunate ones who can count his blessings. Our daughter is married to a wonderful M.I.T. man with a cum laude doctorate in science who heads a research group at Pratt and Whitney in East Hartford, Conn. We have an equally wonderful son, who served during the Korean War in Europe and is presently a flying Captain with the Federal Aviation Agency in Hanscomb Field, Bedford, Mass. The best greetings I can send to you Twenty-Niners is the hope that you will be as happy and content as my wife and I. Best regards to all."

Stephen N. Dilworth writes, "thanks for the birthday greetings, I really appreciate the sentiment. I lost my wife recently and I am just getting organized and adjusted to the fact. Looking towards the future, I can't wait for our 45th Reunion. I had a marvelous time at our 40th." . . . Sculptor **C. Fayette Taylor**, Brookline, Mass., a nationally-recognized authority on airplane engines, uses animal forms and severe geometric shapes that combine his interest in nature and technology in his 12th one-man show recently at the Thomas Crane Public Library in Quincy, Mass. Professor Taylor retired in 1965 from M.I.T. He has had numerous one-man exhibits in Florida, Massachusetts, Rhode Island, and New York. He has also contributed to group shows in Boston and elsewhere. One of his favorite works was purchased recently by the Denver Art Museum for its outdoor sculpture garden. It is titled "Spirasphere," a contemporary six-foot tall structure of stainless steel spirals on a bronze frame. The spirals are flexible and move with the wind.

William L. Hilliard spends summers in Maine and winters in Southern Calif., where they have a married daughter with two children. They drive 'cross country and stop over at Washington, D. C. on their way home in the spring to visit a son. They spent the last three weeks in Mexico visiting ruins at Chicîten, Itza, Uxmal, and Habah. They also spent some time in Mexico City. They plan to revisit there again soon. "There are so many things to see in San Diego County," he continues, "and we have not exhausted our sightseeing interests. We will continue to explore deserts and mountains for a while yet."

Donald L. Hibbard, writes, "I retired at the end of 1972 and moved to 'colorful' Colorado. Kay and I have built a house here in Longmont, which is about 40 miles from Denver. It is quite a change from the Philadelphia area. We wanted to live some place which has some altitude and the advantage of cultural associations. This is the only place in the U.S. which has both. After we moved here, I learned that one of the leading citizens here in Longmont is an M.I.T. graduate. I have joined the M.I.T. Club of Colorado

C. R. Binner, '31 *W. G. Dodge, '31*

and will be looking forward to the Colloquium scheduled at the Martin Marietta plant in late April sponsored by the Sloan School of Management of M.I.T. I'll do what I can to serve the Alumni group—now that I have more time to myself."

Arthur J. Bearse has retired from the Sylvania Electric Products Co., after 27 years of service. He and his wife Ruth spend five or six months in Charlotte Harbor, Fla., and the rest of the time in Gloucester, Mass. "Like most retired people," he writes, "I find more than enough to do such as gardening, woodworking, antique collections, swimming and walking along the beach to pass the time. We have three girls and one boy. Peter chose Harvard rather than M.I.T. He is working on his thesis for a Doctorate in economics. One daughter is a Spanish major, the second one is majoring in Latin, and the third one is trying for her Doctorate in Art History. The only members of our Class that I have kept contact with are **Putnam Cilley**, who recently retired; 'Put' has 2 daughters and he still enjoys sailing in the summer and skiing in the winter. The other is **Leo Goldstein**, who recently retired from his post as a Supervisor in the New York City School Department. He and his wife travel a great deal, mostly in the summer. They have just returned from a trip around the world."

We have word that Mr. and Mrs. **Paul Donahue** announced the marriage of their daughter, Kathleen Mary to Lieutenant Commander John Dwyer White, the 2nd, U.S. Navy, on December 30, 1972 in Nahant, Mass.

I regret to announce the death of **John F. McGrath**, New Smyrna Beach, Fla., on January 19, 1972.—**Karnig S. Dinjian**, Secretary, 6 Plaice Cove, Hampton, N.H.

30

As you know, during the past year the Notes for our Class have, to a considerable extent, been concerned with notices of retirement. It is therefore of particular interest to learn that one of our classmates has not only not retired but has embarked upon a significant new enterprise. We have previously reported that a number of years ago **Jack Latham** founded Cryogenic Technology, Inc. This company absorbed Cryogenic Engineering Co., of Denver, went public, and now has an "Over the Counter" listing.

While Jack has retained a Directorship in this company, his interest has shifted to blood processing and he has recently formed Haemonetics Corp., of which he is President. Jack is primarily involved in new product development, but is active in all phases of the business. In general, Haemonetics operates in the field of supplying equipment for the separation and low temperature preservation of blood components. The Haemonetics line of blood processing equipment is being set up in 20 of the major Red Cross blood centers in the U.S. to implement long term storage of red cells. The stored red cells can be withdrawn and reconstituted to meet temporary shortages of whole blood during periods when donors are scarce. The company makes such items as centrifuges, special pumps with programable controls for driving disposable centrifuge rotors, and tubulation systems. In common with most ventures in medical devices, marketing is the toughest problem. Jack reports that understandably his new enterprise is absorbing substantially all of his time and energy. The Lathams attended the March 27 dinner meeting at the United Nations sponsored by the M.I.T. Club of New York where your Secretary had a pleasant chat with them.

Joe Kania has retired from Pemberton Securities Ltd., of Vancouver, B.C., where he was a partner and director. However, he is still active as a consultant looking after about $20 million of his clients' investments. His list of extra-curricular activities is too long to be quoted in full. Typical items in the list he sent are lecturer in engineering economics at the University of B.C.; former chairman of the Mining and Petroleum Committee of the Vancouver Board of Trade; former Director of the B. C. Chamber of Commerce; former member of the Education Committee of the Canadian Chamber of Commerce and Life Member of the Professional Engineers of British Columbia. . . . **Earl Krall** is manpower planning executive in the personnel division of the Boy Scouts of America in North Brunswick, N.J. He plans to retire August 1 after 38 years as a member of the B.S.A. headquarters staff where he was Director of Statistical Service and Director of the Registration and Subscription Service prior to his present assignment as Manpower Planning Executive. The Kralls have two sons, one a Yale law graduate now working for a Washington law firm and the other a free lance photographer in San Francisco. After retirement Earl plans to pursue his interest in photography and travel. . . . **George Lawson** retired as of January 15, 1971 as Operations Manager of Sylvania and he and his wife are now living in Florida. He says that they recently vacationed together with the **John Hanleys** at Jackson Hole, Wyoming. The Lawsons had four children: George D., who is an engineer at Sylvania; a married daughter Linda; John, who was a first Lieutenant in the Marine Corps and who, after receiving a purple heart citation and Distinguished Service Medal, died in Viet Nam in 1970; and Stephen, who is a senior at Stamford University.

Bill Locklin retired as a project engineer from New York Telephone Co., in the Albany area in 1969. He and his wife do volunteer work for the Red Cross and are active in church work. . . . **Ed Nolan** reports that his youngest daughter Amy was recently married to David Woodruff, a biology instructor at Harvard. Last October he had a session in the hospital for a prostatectomy, but as of the time he wrote he reported being "fine now, better than ever!"

We have a note at hand that **Frances Swarti Frazier** died on February 14. Unfortunately no details are available.

Changes of address: Henry N. Bates, 44 Stuart Ct., Los Altos, Calif. 94022; Ronald M. Hepburn, 75 Fairview Ave., Jersey City, N.J. 07304; David T. Houston, 62 Slayton Dr., Short Hills, N.J. 07078; Horace W. Myers, Rt. #1 236, Lake Joyce, Fla. 33539; Theodore E. Bridge, 54 Williamsburg Dr., Springfield, Mass. 01108; Arthur W. Griffith, 112 Dan Miler Lane, Summerville, S.C. 29483; Dr. Henrik M. C. Luykx, 208 East Chestnut St., St. Michaels, Md. 21663; William W. Driscoll, 143 Beacon, Framingham, Mass. 01701; Morell Marean, 1910 So. Ocean Blvd., Delray Beach, Fla. 33444; Hugh J. Mulvey, 33 No. Hersey Ave., Leola, Pa. 17540; Warren H. Martell, 224 Atlantic Ave., Long Beach, Calif. 90802; Chester W. Turner, 6 Pilgrim Rd., Reading, Mass. 01867.—**Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

31

My apology for being such a poor Class

Secretary after Louise died. Most of last year was spent traveling around the world and in December, I remarried. Her name is Sara Reynolds Harshburger, née Sara Reynolds, Wellesley, '29.

A letter from **Bill Howard** tells of **J. Cobham Noyes'** retirement about eight years ago when he moved to 36 West Beach Lagoon Rd., Hilton Head Island, S.C. 29928; from Cleveland after 24 years with Diamond Shamrock Corp. Cobby says they decided they had had enough snow and ice so they sold their house and built one there on a beautiful golf course. Cobby has three children. Nancy, the oldest, is married to a surgeon, has two boys and lives in San Marino, Calif. Jack is married, has two sons, and lives in Chatham, N.J., and works for Chase Manhattan in New York. Bill, the youngest, served three years in the military and is now at the University of South Carolina. . . . Bill also wrote that **Ed Blake** has retired (again?), is planning to spend some time in California and planned to attend the Mini-Reunion. He sent his regards to his Tech colleagues, especially **Ed Hubbard** and **Ralph Davis.** Word from "Shel" Smith tells of his retirement from Sears Roebuck and Co., in 1969 and his second business career as Senior Vice President of Marine Midland Bank in Rochester. . . . **Randy Binner** is to be congratulated on his promotion to Vice President-Chief Engineer of Great Lakes Carbon Corp. . . . **John Glover** writes that he retired from Ford Motor Co., after 23 and a half years, mostly in the field of gear design. In October 1972, he presented a paper on Planetary Gear Train Analysis to the International Symposium on Gearing and Transmissions in San Francisco. . . . **Norm Dolloff** says he retired as Professor of Geology from California State University in January 1973. . . . **Dave Buchanan** tells me that he and his wife enjoyed their trip to Spain, Morocco, Canary Islands, Madeira and Portugal. My mouth watered when I heard that **Sam Burrows** has acquired an Aquarius 23 which he keeps moored in Wellfleet. (He would like to know what the next step up is—a Balboa 26 or what?) . . . **Bill Dodge** has retired from International Paper Corp. He was the first director of its Corporate Research Center, later becoming President of International Cellulose Research, Ltd., and was Assistant to International Paper's Vice President when he retired.

Congratulations to **Ralph Davis** on his 1972 Bronze Beaver Award. They couldn't have given it to a better man. Congrats also to **John MacBrayne** on his 1972 Engineering Award of the Technical Associates of the Pulp and Paper Industry. . . . **John Swanton** and Louise seem to be enjoying life. During the summer of 1972 he, Louise, Louise's sister, and her husband rented a VW campmobile and camped through Scandinavia and dipped into Russia for six days. They spent five days exploring the Arctic Circle (I am flying over it now) and thoroughly enjoyed their six days in Leningrad and Moscow. . . . While hamming on my amateur radio recently, I was very pleasantly surprised to have my old friend, **John Hollywood**, call me from Greenwich, Conn. When I return from this trip, I hope we can get together. . . . A letter from **Emile Grenier** tells that he finally retired as of January 1, 1973, from the Ford Motor Co. He originally planned to retire last June but stayed to finish his work on the Lectro-Mechanical Seat Belt Monitoring System. From now on, he is going to concentrate his efforts on child safety. . . . He mentions that he has also heard from **Joe Buswell** who spent some time skiing in British Columbia and in Aspen, Colo. Emile also reported that Herb and Irene Chandler's daughter (one of the first girls to be admitted to Yale) graduated from Duke Magna Cum Laude.

A. L. Kaye reports that he continues to teach metallurgy at the Calumet Campus of Purdue University and keeps active in local activities of the Hammond Indiana City School Board of Trustees. As for yours truly, Sally and I spent part of our honeymoon in England, Italy and Spain. When I left for London recently she headed west to Los Angeles, Honolulu, Hong Kong—to visit classmates and relatives—and is meeting me in Tokyo.

Now the saddest part of being Class Secretary is to report the deaths of the following classmates: **David M. Goodman**, deceased December 13, 1972; **Francis C. Crotty**, deceased August 20, 1972; Professor **Richard L. Huntington**, deceased August 9, 1972; Colonel **Stephen C. Gawlowicz**, deceased June 1972; **Winthrop D. Hodges**, deceased December 13, 1972; Dr. **Nathaniel Coburn**, deceased June 22, 1971; **Arthur J. Demars**, deceased September 28, 1972; Professor **Donald L. Dunkler**, deceased September 12, 1972; **Wendall N. Currier**, deceased November 1969. Our deepest sympathy to their families.

Although unfortunately, I was unable to attend our 42-and-a-half Reunion in Mexico City, from all reports it was a great success. The following classmates were there: **Richard C. Ashenden, Jr.; Lawrence B. Barnard; C. R. Binner; Edmund G. Blake; Gordon S. Brown; Joseph M. Buswell; Christopher Chamales, Jr.; Mrs. Edith Elbaum; John P. Elting; Thomas A. Fearnside; Norman D. Fitzgerald; Kenneth Germeshausen; Harold D. Gurney; William D. Harrison; Henry G. Hartwell; Nelson B. Haskell; Edward B. Hubbard; Irving D. Jakobson; Daniel P. Johnson; Richard T. Kropf; Harry Landsman; Claude F. Machen; Robert I. Martin; Carrington Mason; Albert R. Pierce, Jr.; Howard Richardson; David G. Smith; Benjamin W. Steverman; John R. Swanton, Jr.; Antonio de la Torre; John L. Turner.**

Our Mini-Reunion (42 and one half years) was held in conjunction with the Annual Fiesta of the M.I.T. Club of Mexico City in March this past year. This year was the Club's 25th anniversary, a very special occasion; over 200 alumni and guests attended. Our Class was represented by 32 members with wives and families, or a total of 67 people. The M.I.T. Club had planned an exciting three-day program which concluded with *Noche Mexicana,* the highlight, which was a typical Mexican Fiesta at the home and gardens of Nish and Luisa Cornish, '24.

The Class of 1931 had its own special event, a class dinner at La Hacienda de los Morales one of the most beautiful restaurants in Mexico City. Jerry and Laya Wiesner and Howard and Betty Johnson attended the dinner as guests of the Class of '31 as well as Breene Kerr, President of the Alumni Association, and his wife Francis. The Alumni Office was represented by Don and Phyl Severance and Fred and Betty Ann Lehmann. From the M.I.T. Club of Mexico City we had Nish and Luisa Cornish, Ian and Beverly Clark and Conchita Pearson.

Following an excellent dinner, Howard Richardson, Class President, called to order an official meeting. He first recognized and expressed the thanks of the Class to Poly Germeshausen, Chairman of the Mini-Reunion which was proving to be an outstanding success.

Gordon Brown then spoke of the special significance of this quarter century Fiesta, not in a foreign country but in one of the associated Americas. Then he brought up the important business of conferring honorary class membership onto a new peon. He reminded us that the class had conferred this honor last on a distinguished lady, Margaret Compton, and that the requirements are high indeed. He had checked the constitutional problems and found there were no barriers to the new conferee—that he, in fact, met the academic qualifications, and the award could be deemed both authentic and well earned. For a moment it appeared as though the age might be a problem, but taking into account the rapid aging of a president of M.I.T., he will no doubt rapidly catch up. Thereupon Jerry Wiesner was duly awarded his badge of Class of '31 Membership to the applause of all present.

Howard then recognized those who had worked hard to bring about the Reunion. He introduced Polly Germeshausen, Chairman of the Reunion, and Ken Germeshausen, her assistant; our Vice President and Treasurer Claude Machen, and his wife, Jean; Class Agent John Swanton and his wife, Louise; Special Gifts Chairman, Ed Hubbard and Charlotte. Breene Kerr made a few well chosen remarks.

It being Larry Barnard's birthday we all sang Happy Birthday in both English and Spanish.

Howie then spoke of Ralph and Helen Davis. They have never missed class affairs; Ralph was chairman of our 40th. He is now quite ill, therefore they couldn't attend.

Ed Worden, our Class Secretary, and his new bride had written that he hoped to come but, unfortunately, they were unable to make it. Russ Pierce had recently talked with him on their "ham" line.

Don Severance gave a brief talk on "Alumni Association Presidents I Have Known", and expanded it to include a few comments on little known facts about Gordon Brown, Claude Machen, Tom Fearnside, and Russ Pierce.

Howie reminded us that our Treasurer, Bill Jacobs, had passed away since our Fortieth Reunion when he was gift chairman and conveyed our sympathy to Ruth, his wife. The meeting adjourned on the note that we were all looking forward to our 45th. Finally Larry and Jan Barnard will be Co-Chairmen for the 45th.

P.S. Being married to a Wellesley girl, I can see I am going to have to do a better job with the Class Notes in the future.—**Edwin S. Worden**, Secretary, 35 Minute Man Hill, Westport, Conn. 06880

32

One of the lovely ladies who had attended every reunion starting at the 25th, the first time we had our wives accompany us, passed away in March at Greenwich, Conn. **Harry Moore**'s "Maggie" who contributed so much to the success, spontaneity, and gaity of these gatherings will no longer be with us at future meetings. I am sure I speak for the entire Class in extending our sympathy to Harry.

Your Secretary, doing a bit of Florida touring in April, ran into Dorothy and **John Finnerty** in Tequesta looking very fit from exposure to the winter and spring sunshine.

Daniel F. Neilon who had retired as an army major after World War II, and formerly with the Internal Revenue Service, was tragically killed in an automobile accident at Dedham, Mass., in March.—**John W. Flatley**, Secretary, 6652—32nd Street N.W., Washington, D.C. 20015

33

First billing goes this time to **Vernon Bowles**, who wrote a long, fine, handwritten letter. Unfortunately, it has to be condensed, and will lose a lot of Vern's style en route. It is, however, a boon to a fella who needs news. Vern made his first move toward retirement in 1969, when he quit his job as Manager of Process Engineering, Mobil Research and Development, and became the coordinator in a home office project, in Mobil's large expansion in Japan (seems that **Dayton Clewell** was mixed up in that one), this to keep on until retirement in May, 1973. He has made four trips to Japan during these intervening years, and allows that it has become an inspiring method of phasing out. He and Dolores have built a home on the south shore of Block Island, where they will live April to October; and the other six months will be spent in Naples, Fla., where they will build a home on the Naples Country Club Golf Course. They have the lot now. The Bowles have seven adopted and foster children, all doing well. I submit that these Bowles must be fine folks. Space will not allow me to go into much detail about a great trip the Bowles took with **Bill Hall**, in his 38′ ketch, acting as crew, all the way from Marion, Mass., to Chesapeake Bay, where Bill winters his boat. The trip was in August, last, and apparently was a leisurely trip; long enough to really enjoy the sail as a sailor's dream. I cannot describe the masterful way that Vern tells his story, but I can say that he really can write. Bill Hall, it seems, has been with Arco for quite some time and expected to retire in January, '73. It is indeed unfortunate that Bill never learned to write, as he could tell a real story. Or, perhaps he is either modest, or he does not wish his story to be known.

Bob Dillon comes through with one of his rare short ones, welcome indeed. Alice and Bob had just returned from an eight-month stay in Puerto Rico, where Bob was a great help in starting up Union Carbide's huge new plant at Guayavilla. Back to Texas, Bob has been appointed Quality Assurance Manager of U.C.C.'s Plastics and Chemicals Distribution. This is a very interesting and challenging position, and it is fortunate that he can remain located in the Texas City plant, which is close to home. Bob is a man of few words, but he came through, did he not? I find, however, no mention of being on Cape Cod, come June. . . . From **Bill Laird** we get a fine combination of **Cal Mohr**, and **Beau Whitton**. As to Cal, he got a lot of news about classmates, and as for Beau, he gets a few of his own details in. He gives his retirement the scientific treatment; he has it figured that, by dropping a few responsibilities each year, accurately handled, he can achieve full retirement at age 100. By moving to a suburban office location, he saves a half hour each day, but, the time saved appears to become elusive as quicksilver. So, Cal-style, Herb Beers, '34 architect, is his next-door neighbor. Just a mashie shot from the Lairds, son George and his Ann, will live in a house that is now being built, where they will have an excellent view of the Brandywine Gorge. "We are assembling a closely knit, delightfully provincial, neighborhood." Now, I discover that Bill Laird is "Chick." The Lairds, for 20 years, ran a summer farm school for training young men, 16-21, in farm practice, and heavy earth-moving equipment. They even had a cherry picker. Chick and Winnie moved back to Wilmington, and find it delightfully familiar, and a welcome change, excepting February, which is not as good a month as one might hope. So, Chick and Winnie will do their travelling in February.

Now, it does this old heart good to see a fine letter from an old Course II man, **Ellery Clark**. It appears that the Clarks finally made the Grandparents club. Daughter Margie and husband came through with the first granddaughter. Louis and Ellery took a plane, train, bus, foot, and cruise ship trip to Alaska last September, to visit both Alaska and parts of British Columbia. Both the Clarks are quite active, taking camping and hiking trips, square dancing, and some short travels. They plan a freighter cruise 'round the world in '75, his retirement year. Louise, it seems, is an accomplished artist, and works in ceramics, Ellery offers to have my coat of arms done on a special plate. A fine idea, I must admit. Ellery is also an enthusiastic skiier, mostly California, but twice in Colorado. It is two years now since he has had an accident, always a hazard; and he has been a skiier since he was six. Wow! Ellery is also a target pistol shooter. Since 1962, he has been competing with muzzle loaders, flintlocks and percussion pistols, and at one time was considered to be one of the best shots in the country, but no more; he doesn't say why. Harvey Aluminum is now Martin Marietta Aluminum, and Ellery is still the top stress analyst. He allows that he doesn't make the kind of dough he hears about, but they have been happy and healthy, and moderately successful. The Clarks have lived in an apartment for some time now, right on the Pacific, they are outside the smog belt, and there is generally an ocean breeze.

We received a real long one from **Ken Moslander**. Last time I saw this guy was the 30th at Woods Hole. Ken, your private life is all over, but only so far as M.I.T. men are concerned. Ken fears that our trip to the south seas suggests a bit of foreboding, and advises that Leona chain me to the ship's bar. Ken, in many cases you might well be right, but for me, you should definitely banish all fears. It appears that Leona has none, and who should know better than she? Last year Ken was General Manager of the Automative Division of the Cleveland Weatherhead Co., and, while there had a slight coronary experience. Nobody claims that his beloved Cleveland is a winter resort, so he went to Fort Myers, Fla. There they built a house complete with a swimming pool, took an interest in golf, and fishing and boating. That's the life, son. Further, Ken allows that he is still able to maintain his acknowledged proficiency in bridge. He is second in command of the local chapter of S.C.O.R.E. Oldest daughter has provided the Moslanders with two grandsons. Second daughter has provided only one grandson, probably because the in-law is a "disestablishment" doctor of Political Science. The other one, per Ken, is an establishmentarian. His other son is another anti, unmarried, and is connected with the Missionary area of the Methodist Church. Ken is not sure of the 40th for him. Ken asks if anyone ever hears about or from his classmate and fraternity brother, Frank K. MacMahon. Ken's address upon request. Our class agent, **Bob White** writes in. Listen to what the rat has for me, "Your 50th wedding, hey? I knew you were plenty old but I never thought that child bride of yours was old enough to be married that long." So, we come to the message. Three of Bob and Wilma's children are married and they have six grandchildren, mostly quite young. Bob is still working, Vice President and General Manager of needle bearings, world wide, for the Torrington Co., which involves some travel for both of them. And, they get away for a vacation quite often. They had three weeks in Hawaii last March, and expect about the same in Mexico this spring.

Bill Huston, always a reliable source, gives us an unusual look at his work. He was Mission Director for the last July N.A.S.A. mission. On an earlier Nimbus launch, he was Director, also. Bill attached a photo taken during the spacecraft flight, of the south shore of New England. In December 1972, another Nimbus weather launch was made at Vandenberg Air Force Base, in California. Bill was there also.—**Warren J. Henderson**, Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

34

Your Secretary is taking a well-earned

vacation in the form of a trip to Europe from April 24 to June 8 hitting the high spots in England, France and the Netherlands. His Assistant will try to do his best with the rather limited amount of material that has arrived at his usually cluttered desk.

A letter from **Bill Ball**, "As some of you know, I retired from Ethyl Corp., in 1970, to assume the position of Director of Member Relations for N.A.M. in the Greater New York City Area. That includes Southern Connecticut, so I see a few of our group there. I now have to call upon some of the young M.I.T men like Bob Flood, '35, who won the Stock Brokers Contest in 1933 which yours truly and **Ed Asch** ran. Maybe that is why Bob is a Vice President of Union Carbide, today." Bill tells us that **Art Esslinger** has retired from Interpublics (McCann Erickson), but he has not heard from him in years. Also Ed Asch is still living in Houston inspite of the hot weather. Bill's children are doing well. Nancy is White House Reporter for *Newsweek* in Washington. His son Dick finished Wharton Graduate School and is now managing fixed income funds for banks that need help.

A letter from Gordon Calderwood, '27, speaks in the highest terms of the contribution made to the city of Rochester by **Peter Barry**. Peter did not graduate with us, but his suffering during a two year bout with cancer occasioned much sympathy and his passing has caused his community to lose a valued citizen.

A telephone conversation with **George E. Best**, Course XIV, disclosed the fact that he has been with the Manufacturing Chemists Association, here in Washington, D.C. for the last 13 years. He is currently Vice President and Technical Director. He is slated to assume the duties of Secretary-Treasurer on July 1. After graduation George worked for New Jersey Zinc and later Pennsalt. Prior to coming to the Association, he was with Mutual Chemical Co., of America for ten years in Baltimore. He makes his home there. Commuting and late Association meetings keep him from being active in either of the M.I.T. clubs. George's wife is from East Greenville, Penn. They have a son, now 27 and a first lieutenant on active duty with the army. He has almost completed a Ph.D. in history at the University of South Carolina. George's work with the Association puts him in contact with **Harold Thayer**, President of Mallinckrodt Chemical Co. Harold is on the Board of Directors of the Association and is Chairman of its Executive Committee.

If permitted, I might add a few lines about myself. After returning to the U.S from my trip around-the-world in the spring of '72, I worked as a volunteer in the campaign until Election Day. I was in charge of a rather large mailing operation, which Mr. Nixon came over one day to look at. In January, at the invitation of a Harvard friend, Mary Elizabeth and I participated in a week's Ivy League cruise in the Caribbean. After flying to San Juan our ship made stops at Martinique, St. Lucia and other ports. Since then I have been working at the Smithsonian Institution organizing the holding of local postal markings. With the development of central dispatching offices stamping mail, "U.S. Postal Service No. 234" instead of the local community's name, the Division of Postal History wants their examples of old markings organized for proper future preservation and reference.—**George G. Bull**, Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

35

I am having to dig to the bottom of my mail bag for news this time and most of it comes from notes included in the survey returns to Bob Forster last year. **Jack Talburt** wrote "Am now a teacher at Miami University (Ohio) full time in Industrial Technology Department. Teach things like fluids, mechanisms, value engineering, manufacturing processes. A lot of work but fun. Not much salary but pick up a little on consulting now and then. Am a member of Value Engineering Society and American Society of Mechanical Engineers as well as a teachers' organization. Am Director of Educational Materials for S.A.V.E. and Vice President of the local chapter. Earlier this year I was hospitalized for five weeks with bladder and liver trouble. Now almost back to full health but no more drinking. (Lost one reason for going to reunions.) My wife is a nurse at Kettering Memorial Hospital and still is as beautiful as ever after 30 years of marriage. My oldest daughter (28) is a graduate of Barry College in Florida and married to Roger Beggs (B.S. in Finance) who works at Tennessee-Eastman in Kingsport, Tenn. They have one child, my one and only grandson. My 25-year-old son will finish a four-year hitch in the Air Force in March '73. My youngest is a 16-year-old daughter in high school. Brother! She is something again. We don't really have a generation gap, but it sure is difficult for a 58-year-old male—stubborn and logical (I like to think) engineer to keep his senses with an emotional, spontaneous, and moody female teenager."

Samuel P. Brown reiterates the fact that he cannot get to reunions and homecomings because the regular June meeting of the Board of Directors of Kaiser Steel Corp., always falls on the first Monday in June and he has to be in California the previous day. . . . **Hal Everett** wrote that his daughter Jean was married to Philip Bonafide who was a third-year law student at Georgetown at the time of the wedding March 28, 1972. Hal and his wife enjoyed a beautiful vacation on Saint Maarten (Caribbean) in May '72. In June a year ago a cataract operation on his left eye has resulted in Hal's spending more time in Marketing Consulting activities than Sales Engineering Representation. . . . **Irving Banquer** wrote, "I am retired and my wife and I travel several months each year. Two of our three daughters are married and live in the Boston area; our third is in medical school in California. Between trips I garden and function as a repairman for the family and as a builder of things for our two grandchildren. Frequent 'Y' workouts and jogging keep me physically fit."

Phil Johnston's note reads: "Not much exciting—still operating my own company as I have for nearly ten years—Lehigh Fluid Power Inc., in Lambertville, N.J. We manufacture pneumatic cylinders, valves and other automation gear—a growing industry so you can afford to make a few mistakes and still survive nicely." . . . I have one more note that I will save for next month to interlard with all the golfing news you will be receiving on our 14th year of the Class Tournament. Everyone cannot be working the 80-hour week that I am putting in to get a new business going, so write to—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Ma. 02160

39

Dr. **Myer M. Kessler**, Associate Director of Libraries at M.I.T. since 1965, has been appointed Coordinator of Technical Systems in the M.I.T. Information Processing Services office. His new assignment deals with computers in libraries, a field in which Dr. Kessler has done pioneering work. . . . **Nicholas Shoumatoff** has joined I.T.T. Rayonier Inc., as Director of Project Planning and Development. Rayonier is the forest products manufacturing subsidiary of I.T.T. Corp. Since 1969 he had been Vice President of Pulp and Paper Mill Operations for Parsons and Whittemore, Inc., in New York. He is presently a candidate for a Ph.D. in international corporate finance and operations research from New York University. For many years he has been active in the Technical Association of the Pulp and Paper Industry, and has authored or coauthored over 40 published papers, reports, and articles.

We '39ers read about this next item in an earlier issue of the *Review*, but it is certainly newsworthy to note that it is a classmate who was appointed Vice President for Resource Development.—**Oswald Stewart**, Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

40

I had a pleasant chat with **Joe Greenberg** recently on one of his frequent trips to Washington. Joe is a Vice President of A. T. Kearney and Co., management consultants. He is located in Chicago but his organization has a Washington office practically a stone's throw from mine.

By the time this column reaches you, my wife and I will be in Europe celebrating our 25th anniversary. We are going to take approximately a month which is the first time I have taken over a week off at one time.

Willard Morrison has been named Director of Research and Engineering for The Washington Group, Inc., of Washington Mills Co., of Winston-Salem, N.C. He joined Washington Mills in early 1972 as Director of Marketing/New Products Development. In his new position he is responsible for the development of and testing of new products for the company's food and textile operations, providing engineering support on special products for all operating units and man-

agement of the Mayberry Commissary. Previously he was President of Medical Plastics, Inc. Willard and his wife Janis live at 1896 Meadowbrook Dr., Winston-Salem, N.C., with their three children. . . . **Louis Russoniello**, one of our Class's better known architects was in the news recently when he requested President Nixon to place an embargo immediately on the overseas shipment of all lumber in order to bring down the skyrocketing construction prices. Louis is with the architectural firm of Russoniello, Russoniello and Domanish in Scranton, Pa. Louis has also been reappointed to a two-year term on the Philadelphia District Advisory Council of the Small Business Administration.

Connie Schuerch who is the Chairman of the Department of Forest Chemistry at the State University College of Environmental Science and Forestry, Syracuse, N.Y., received the Syracuse Section Award for 1973 of the American Chemical Society. . . . Major General (retired) **Robert F. Seedlock** has joined the engineering-architectural-planning organization of Parsons, Brinckerhoff, Quade and Douglas in New York. His work will be primarily in the management of major public works projects, particularly in the field of transportation. Previously he was Chief Engineer and subsequently Director of Construction and Development of the Port Authority of Allegheny County in Pennsylvania and was responsible for rapid transit facilities. . . . **Herb Hollomon** has been appointed a member of the Board of Avco Everett Research Laboratory, a recently formed subsidiary of Avco Corp. Don't forget to write Al.—**Al Guttag**, Secretary, Cushman, Darby and Cushman, 1801 K. Street, N. W., Washington, D.C. 20006

50

Eli I. Goodman recently returned from representing the U.S.A.E.C. in Tokyo—uranium enrichment and nuclear power were major functions, as was cooperation with joint-ventures by American industry. Eli is a staff member of the Office of Planning and Analysis of the U.S.A.E.C., which consults directly with the Commissioners on general energy policy and international developments.

John R. Flynn has been chosen President-Elect of the M.I.T. Club of Rochester, N.Y. He is scheduled to succeed **Donald W. Ramsey** who is this year's President. . . . Miss **Margaret T. Coleman** of Cambridge, Mass., has been appointed Manager, Analysis and Development, of the nation's oldest canning firm—William Underwood Co., of Watertown, Mass. Margaret has been associated with the Underwood Co., since 1966, serving most recently as Operations Analyst and Acting Director of Analysis and Development. . . . **James R. Butterworth** of New Rochelle, N.Y., was promoted to the rank of Colonel in the U.S. Army. He received the promotion at the U.S. Embassy in Paris, France, while on temporary duty in Europe in February. Colonel Butterworth entered the army shortly after completing his degree in geophysics at M.I.T. in 1950. He has served in Korea and in Vietnam, and has been awarded the Bronze Star, the Joint Service Commendation Medal, and two awards of the Army Commendation Medal. A Distinguished Graduate of the Program Management Course at the Defense System Management School at Ft. Belvoir, Colonel Butterworth is an instructor at the school. He is also the project manager of System X, a new approach to the problem of developing qualified and competent managers for the Department of Defense weapon system acquisition process. He lives in Arlington, Va.

William H. Enders reports that he is beginning his third year at the Executive Headquarters of the Magnavox Co., in New York City. His responsibilities as Director of Business Development, include management of corporate Research and Development projects, acquisitions and international joint ventures. Some new products now entering the market to which he has contributed include Odyssey (an electronic game that uses the TV set as a display), a hand held color television camera to be used with a video tape recorder and a system for watching (and paying for) recent movies via C.A.T.V. His son. Gregory, is in his freshman year at Lehigh University and daughter, Kimberly, is a sophomore at the Hun School in Princeton, N. J., where they live. She was the first girl at Hun to receive a varsity sports letter. Bill and his wife, Jean, spend much of their leisure time relaxing at their vacation home on Lake Sunapee in Newbury, N.H. They recently celebrated their 20th wedding anniversary in the Hawaiian Islands.—**John J. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

52

The featured speaker at the Aviation/Space Writers Association Mid-East Region luncheon/news conference, January 1973 was **Robert R. Schwanhausser**, Executive Vice President for programs at Teledyne-Ryan Aeronautics, San Diego, Calif. Bob is one of the leading authorities in the U.S. in the field of remotely-piloted vehicles. His presentation covered the uses of the remotely-piloted vehicle in terms of national defense policy. . . . **Bruce G. Curry** has joined the Hertz Corp., as Vice President, Management Systems and Services. In this position, Bruce assumes responsibility for all of Hertz' management information systems activities. Prior to joining Hertz, he had been Vice President for R.C.A. Corp. Bruce, his wife, Joanne, and their three children reside in Wayne, N.J. . . . The R.C.A. Laboratories Solid State Technology Center in Somerville N.J. has announced the appointment of **John W. Gaylord** as Manager, Power Technology. John has been an R.C.A. employee since 1952. In his new position, he is responsible for the design and development of advanced solid state power devices. He received his master's degree following his graduation from M.I.T. in Physics and also from Franklin and Marshall College in 1958. He is married to the former Joan Pindar of Lancaster, Pa., and lives with his three children—Deborah, 16; Jack, 15; and Susan 11;—at 52 Monroe Lane in Princeton, N.J. . . .

A note has come from **Howie Fawcett** saying that he has moved to Jacksonville, Fla., to accept a position with a new company created by Tennaco and Westinghouse. This new company is called Offshore Power Systems and is being set up to manufacture floating nuclear power plants. . . . **Jack Larks** writes that he has been appointed Department Chairman of Civil Technology at the University of Houston. His recent activities have included arranging for a group of Houston M.I.T. Alumni to attend the 25th M.I.T. Mexico City Fiesta and work with the U.S. Army Reserve 75th Maneuver Area Command, testing and training troops in the 5th and 6th Army Areas West of the Mississippi. . . . General Radio Corp., has announced that **Harold T. McAleer** has been named as Engineering Vice President of General Radio. In this new position, Harold will be supervising engineering staff groups, engineering services, corporate design standards, microelectronics, and the custom-products operation.—**Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741

54

Bob Reichard, our first missing classmate of the month, is alive and well and living in Wellesley. No wonder we never hear from him—way out in Wellesley. Bob has somehow "rapidly acquired many of the rewards and most of the liabilities of the burdened middle class; an exemplary wife, three healthy kids (two of whom have reached teen age in no time at all), a sufficient house in a nice spot with a healthy mortgage (which matures with agonizing sloth), two small sailboats, five cross-country ski outfits, and most recently a camping trailer." During a trip to Europe three summers ago, Bob visited Dick Neergaard and his family for a few days. It was great to hear from Bob and we are going to follow up on a suggestion of his for a study of non-vital statistics. More about that later.

Fred Holmes is completing a book on the early experimental career of Claude Bernard, showing interplay of thought and investigation in daily record of his laboratory activities. Fred has three children: Catherine, 10, Susan 8, and Rebecca, 5. Wife Harriet isn't telling. She is from Belton, Texas, though, which reminds us. Where is **Mike Boylan**? Last we heard was that he made history by being turned down for car insurance by Lloyd's of London. . . . **Bob Breed** is an audio-video engineer with C.B.S. . . . **Bruce Brosler** is President of Tech Furniture. . . . **Ev Chambers** is in the Air Force and associated in some way with the C5A transport. . . . Dr. **Guerdon Coombs** is at the Marshfield Clinic in Wisconsin, and **Dave Cooper** is teaching at Brown University after receiving a Ph.D. in applied math from Columbia. . . . **John D'Amico** who also is a Ph.D. (physics 1958) works at Western Electric Research Center, and **Jack Drake** is with Buell Industries. . . . **Bob Egan** is a supervisor of Naval Architecture at the Philadelphia

Naval Shipyard. . . . and **Will Fiske** is at Gulf Oil's Warren Petroleum Subsidiary, and **Richard Gordon** is a consultant to the Food and Drug Administration. . . . **Roger Griffin** is General Manager of Marine Hydraulic Systems of Baltimore. **Paul Dross** is teaching at the University of Vermont and building a 23-foot sailboat in his spare time, . . . and **John Tiboni** is a partner at Alderman and MacNeish.

Those publishing include: **Dave Chesler**, a paper on "Signal Processing in Nuclear Medicine"; **Fred West**, a paper on "High Dispersion Spectroscopy of Visual Double Star Sigma 2173," and **Dave Howes** on the "Visual Sex Life of Rare Species on Crane's Beach."

Manny Otis has been active in Twin Cities, Minn., for the Alumni Fund and was recently cited for his work as a leadership gift chairman. . . . **Phil Bonomo** has also been cited for his work in the Silver Spring, Md., area. . . . **John Preschlack** is a Vice-President at I.T.E.C., heading up their Instrumentation and Control group. Jack and his family are looking for a charming, reasonable five-bedroom home in the Weston-Concord area. Anyone with an extra one, please contact Jack directly. You wouldn't believe it if we reminded you that we will be celebrating our 20th anniversary one year from now, so we won't remind you. Have a good summer. Twenty years, good heavens! Don't just sit there, do something with your life.—**Dave Howes**, Box 68, Carlisle, Mass.; **Chuck Masison**, 76 Spellman Rd. Westwood, Mass.

55

Well, you didn't write. And I was counting on some news from you for this issue. How do you think your classmates will ever know the dog had puppies, or that you were late again with the mortgage payment, or that the kids want to move to Hawaii if the plant closes down?

But there is some news from a select few this month. **Joyce Davis**, who received her J. D. degree in 1971 from Fordham University Law School, was admitted to the New York Bar in February 1972 and has been an attorney with Consolidated Edison Co., since June 1972. . . . **Ralph Shoffner** has moved to Portland, Ore. He has a new job as Director of new product development for Richard Abel and Co., an international firm that provides books about the arts and sciences to libraries and individuals. He finds Oregon rainy but beautiful. . . . **Al Tarbox** is Vice President of Lexington Computer Management Group, Inc., a small consulting firm based in Burlington, Mass. . . . **Dell Lanier Venarde** is attending the University of Delaware, planning to become certified to teach in the public schools.

The past year has brought some of the best and the worst times for me. Last fall, kidney disease reached end stage, and after a relatively short period of dialysis I received a kidney transplant from my sister. On the scale of gift giving there are some unmeasurable increments. Then, in the beginning of the year I was named a Fellow of the Institute of Electrical and Electronics Engineers. So I got to sit on the stage at the annual banquet and think what a grand fellow am I. However, my fingernails aren't too clean after changing the oil in my nine-year-old car.

It is pleasing to hear that **Oswald Fuzzer** has finally been released from jail after the misunderstanding over his agricultural exporting business. He arrived home in time for the birth of his thirteenth child, Garibaldi. Oswald is planning a career change, and is now president of Computer Bugging Fund, Inc., an equity extermination company. The Fuzzers attended the memorial serivce for **Homer P. Harechester** at the Seacaucus water purification plant and alpaca tannery. The service was held before Homer's trip, as it was feared he would be unable to make a later one. A twelve-foot wreath of broccoli was thrown into the sea by **Larry Begetta**, who reports this is another first in agricultural diversity, except in New Jersey. Send news quick.—**Allan C. Schell**, Secretary, 19 Wedgemere Ave., Winchester, Mass., 01890

61

Very slim pickings in the Class Notes area these days. Since a lot of the data on which I base these immortal words comes along with your contributions to the alumni fund I would hazard a guess that our class has a very dismal record. Cough up you guys! The 'tute needs the money and I need the info.

An unsolicited letter this month comes from Rachel Kopel who is married to a modest **LeRoy Kopel**. She is rightfully proud of his recently granted patent (#3,721,227) which was written up in the *New York Times* last March. The article says that LeRoy and some other people at Aerotech Labs in Lewiston, Pa. invented an apparatus which uses ultrasonics to aid in the removal of internal tumors and the drainage of cysts. Rachel's letter goes on to say that the Kopels live in McVeytown, Pa., and that LeRoy has been Manager of Research and Development for Aerotech for the last three years. You're a good person Rachel Kopel—thank you. . . . Good old **Joe Harrington** wrote to say that nothing had happened to him recently. However he did enclose a reprint from the *Management Review* of last summer with an article by **Bill Leffler**. It was all about such esoterica as "corporate relocation" and it seems to be either a) tongue in cheek or b) way over my head. In any event a little blurb at the end of the article mentions that Bill is currently heading for a Ph.D. at N.Y.U. and I can't see any reason why we shouldn't accept this to be true.

To give you an idea of how bad things are getting in securing material for Class Notes, I cleaned out my desk the other night looking for material which might have gotten waylayed by the mischievous hands of small girls. To my surprise I came across a couple of letters. One from **George Gladfelter** is dated last June, "This is a short note to let everyone know that I have survived the June 9 (1972) flood without injury or even property loss. I have now been at the South Dakota School of Mines and Technology over 6 years as a director of the computer center and never dreamed that the tame little Rapid Creek could be so destructive. The toll is now 224 dead and about 40 missing. Two of the dead were professors at the School and a number of my colleagues lost their houses. As it happened I crossed over Rapid Creek on the way to my home from work about 15 minutes before the rampage started. Things are pretty much back to normal now with the Black Hills looking beautiful and Mount Rushmore attracting the tourists. I hope more M.I.T. people will visit in the future."

The other letter comes from **John Castle** and it is from the Spring of '72! John wrote that he was the Director of Process Development for Marine Colloids, Inc., in Rockland, Maine. He says "In some circles this might be called a step backwards—from a position heavy in marketing (and) bullshit to one dominated by chemical engineering unit operations. My job, in essence, is to reverse the latter domination as far as M.C.I. is concerned." The Castles now live in Camden, Maine, and welcome all friends who manage to get that far north. . . . **Alexander Ross** wrote more recently and says that "I have moved around quite a bit with Standard Oil of California, since graduation having been in Hawaii, L.A. and San Francisco and now back again in Hawaii. Presently I am in the field of Personnel and employee productivity. My wife is a Wellesley graduate of 1961 and we have just had our second child, a girl. Now we have one of each. We don't miss the chill and snow but do miss New Engand in the fall."

Hank Lett says that he has two children also; to wit: Andy, 9, and April, 1. He says that he is Director at Management Information Systems for the Skill Corp., which is true. . . . **Bob Pease** is still at Philbrick inventing D-to-A convertors and ultra-linear voltage-to-frequency convertors and he is also still hiking with his family; most recently in New Hampshire and Colorado. **Bill Dyer, Jr.**, is now chief of Aeromedical Services at the Mather A.F.B. hospital in California. **Paul Robertson** writes that "I have returned to the field where I started—telephony. I started in April as Principal Engineer, Special Projects for Telecommunications Division of North Electric Co. [These titles are getting more hairy every year—A.B.]. We have adopted a third child, Sara Jane (Sally) who is now 1½. Our others are Ann, 5½ and Timmy, 3½." . . . **Wes Hilton** still works at Skripts Oceanographic but he doesn't go out to sea any more. Now he just holds hand with a computer. "At long last," says Wes, "I am putting down roots as we are building a house here in Del Mar, overlooking the Pacific."

While on the subject of the sea I recall an article in *Sports Illustrated* last March that some of you may have seen about **Jerry Milgram**. Jerry, who in real life is on the faculty at M.I.T. in the Naval Engineering department, is the most hated sailor on the south eastern circuit. He has designed, and built, a yacht which takes advantage of all the loopholes in the design rules so that he receives a very

nice handicap (rating). This allows him to win lots of races on corrected time. It appears that the other skippers don't like him because a) he wins all the time, b) there are women on his crew, c) his boat is ugly and d) he ain't rich. So they are getting together to work out an arrangement by which Jerry's boat gets screwed but everybody else is not affected. All this has happened to Jerry before and I know he will take revenge in some ingenious way. . . . Finally I have here a note from **George Harrison** who says that he got an M.B.A. from Seattle University last June and has started a new career in institutional sales in the Seattle office of Merrill Lynch. His specialty is Municipal Bonds. He says that he is "quite pleased with this type of business." He spent four months in New York City last summer training at Merrill Lynch.

That's it. My file is empty. If you won't write, at least get your wife or mistress to do it for you.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

62

Raymond P. Wenig has developed an interesting management consultancy and educational venture in Australia and spends six to eight weeks per year assisting Aussie management improve their use of computers and information systems.—**Gerald L. Katell**, Secretary, 122 North Maple Dr., Beverly Hills, Calif. 90210

64

NO NEWS IS BAD NEWS! That's the story this month, when no alumni clippings and no Class Heroes came forth by the deadline date save one.

Our Class Hero this month is **Mike Sullivan**, who has recently been named Director of Marketing for Adobe Creek Lodge, a two million dollar recreational park in California. Since receiving his M.B.A. from Stanford in 1971, Mike has been a management consultant to a number of businesses in the San Francisco area. Mike still works part-time for his consulting firm of G. M. Sullivan and Associates. To remedy this dire situation in future months, please let me know what's going on amongst the multitude of our classmates. Best wishes for a happy summer.—**Ron Gilman**, Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

66

Martin Krone is beginning work at Bell Telephone Labs in New Jersey after a two-year teaching appointment at Yale University. . . . **Dick Wolf** left Lockheed to join a large construction company in Chicago. . . . **Barry Skeist** is now interning at Swedish Hospital in Seattle. He will be returning to Jefferson Medical College this year to begin a residency in radiology. . . . **Phil Perkins** is now married and living in Needham. He is working for Teradyne in Boston where he is responsible for the design and development of computer operated linear circuit test systems. . . . **Karen Henry Shields** says she is "alive and well in Weston." She has two children, Tom, 5 and Kua, 2. She is doing marketing for a national speed reading company in the New England area and is forming a company to train women in sales marketing and to place trained women. **Tom Jones**, 59 Commercial Wharf, Apartment 6, Boston, Mass. 02110

67

I am pleased to announce that my bachelor days are numbered! By the time you read this I will have taken the big leap to family life; the magic date is April 14. The dear recipient of my affection is Sharlotte Althausen, a 1969 graduate of Mills College. Shar teaches English and drama at a junior high school in Livermore. We will establish our home in Fremont, and we hope that all of you will feel free to visit us and share our joy. Since Shar and I will be on our honeymoon when the regular packet of news arrives from *Technology Review*, this column will consist of leftovers (no disparagement intended). . . . **Chuck Greene** is developing a small community on 750 acres in northern Ontario for summer and winter residents. Anyone who is interested should get in touch with him at 1051 Spadinee Road, Toronto, 12, Ontario, Canada. . . . **Barry Watkins** has changed positions in the city government in Rochester, N.Y.; he is now in the Department of Urban Renewal and Economic Development. Wife Marty has also changed jobs and is now with the County Department of Social Services. . . . Jackie and **Sheldon Bayer** have two sons, Matt and Jesse. Sheldon was discharged from the navy about a year ago. He is now a design engineer for Avco Electronics in the Communications and Space Division. . . . **Jim Foster** married Paula Siederman September 13, 1972. Paula is a teacher in New York City. . . . **John Mauer** received a Ph.D. in English and Applied Science from Yale in 1972. . . . **George Nybakken** expects to get his Ph.D. from University of Michigan in August. George has been working on research projects involving pneumatic tires. The Nybakkens have two children, Katherine, 1, and Kristopher, 4. . . . **Paul Tarantino** is completing a three-year tour with Patrol Squadron 46 at Moffett Field, Calif., while the navy is deciding whether to keep him for another two years. If Paul stays, he will have instructor duty at Moffett; otherwise, he intends to bum for a while and start a slow search for gainful employment.

Robert Dann has finished the course work for his Ph.D. in comparative literature. He is living in Madrid this year, studying for exams and doing thesis research. His wife Mady is doing her master's in Spanish with N.Y.U.-in-Spain. They spend their spare time looking for antiques and taking pictures. . . . **Richard Koehler** completed his Ph.D. in Electrical Engineering at Stanford in March, 1972, and is now working for Xerox in Rochester, N.Y. A second son, Kevin Peter, was born June 4, 1972. . . . In August **Fred Orthlieb** married Vera Kemper, Mt. Holyoke, '71. . . . **John Rible** is Director of the Data Processing Center at Community College in Beverly, Mass.; he also teaches. John leads a quiet but complicated life in a small resort-artist area of Gloucester. . . . **Leonard Fenocketti** has returned to the academic life after two years as an enlisted man in the air force in the south. He is studying chemistry at Yale. Last June he married Mary A. Hangino, an Albertus Magnus College graduate.—**Jim Swanson**, 46703 Crawford, Apt. #1, Fremont, Calif. 94538 (until June 10, 1973)

69

Greetings from the Upper Midwest! For those of you who ive in the Twin Cities area and cannot attend the fourth Mini-Reunion of our Class this summer in Cambridge, I hope to have a reunion of sorts here in the Twin Cities. It won't be a Chuck Berry beer blast but an informal outing where classmates can get together. Members of other classes who read this column are also welcome. If interested, just drop me a note. Perhaps our beloved friend the blue dwarf will put in a special appearance. If anyone would like to arrange a get-together in other locales, let me know and I will forward to you any necessary information and provide any assistance in contacting other classmates.

Among this month's letters is a note from **Mike Ginzberg** who is running the Mini-Reunion in Cambridge this summer. Anyone interested in assisting Mike with the tasks of putting the reunion together or for getting information about it should contact him at Apt. 22, 25 Mansfield St., Somerville, Mass. 02143. He can be reached by phone at 776-5600 (home) or at 253-6607 (school). Mike is currently at the Sloan School working towards his Ph.D. which he expects to receive within two years.

I have received only a few notes from classmates this month. . . . **Lewis Flagg** has "done the unexplainable—moved from the beautiful San Francisco Bay area to Chicago." He currently occupies the position of Administrative Assistant to the Dean of the School of Social Service Administration at the University of Chicago. His tasks include the management of the budget, supervision of the clerical and technical staff, and overseeing the maintenance of the plant and equipment. Lewis had received his M.B.A. from the University of Chicago a couple of years ago. . . . **Robert A. Schaeffer** and his wife Elaine are continuing their work in social-change directed fields. Elaine is the Director of an open classroom in East Boston Head Start while Bob is a field secretary for Citizens for Participation in Political Action, the Massachusetts "new politics" organization. Bob reports "For those who care, I still haven't gotten a bachelor's degree and haven't missed it in the least." . . . **Shelley Fleet** has discovered that Cleveland is a "dreadful place." She plans to be in Boston this summer. Recently, Shelley saw Larry Stein interviewing for a residency in neurosurgery at a Cleveland hospital.

Michael D. Meloy is a Lieutenant Junior Grade in the U.S. Navy and is stationed in Naples, Italy. Michael is a pilot and is land based in Naples but flies Helos and prop cargo planes around the Mediterranean area. He is married to the former Gail Hughes, a 1971 graduate of Wellesley. . . . After completing two years with the U.S. Public Health Service, **Allen Wiegner** spent the fall in Europe, mostly in Berlin where he studied German at the Goethe Institute. Allen re-entered M.I.T. this past spring as a graduate student in electrical engineering. . . . **Rik Anderson** is now assisting in the management of the United Air Lines' program for developing fully instrumented noise abatement approach equipment and procedures. This work is being performed by U.A.L. under contract to N.A.S.A. Rik recently returned from Africa where, among other activities, he climbed Kilimanjaro.

That's all for this month. Have an enjoyable summer and drop me a line when you have the opportunity!—**Richard J. Moen**, Secretary-Treasurer, W-1781 First National Bank Building, St. Paul, Minn. 55101

72

Spring, and a young man's fancy apparently turns to thoughts of writing his Class Secretary, as well as more important matters. All of which is to say that I received three delightful letters this month. **Vic Kalasinsky** wrote, "I was one of those who graduated a semester early, in January 1972. I worked until September and now I'm in graduate school at the University of South Carolina. I'm doing work in Chemistry under the direction of Dr. James Durig, who got his doctorate at M.I.T. a few years ago." . . . **Terrill Chang** wrote of taking a course with **Chuck Sollitt** at Oregon State last fall. "Another coincidence was meeting John Berkey, '70, on O.S.U.'s research vessel *Yaquina* in early March—100 miles out in the Pacific. You can't escape the 'Tute! As for myself, I'm struggling towards an M.S. in Mechanical Engineering with an emphasis on ocean enineering."

I also heard from **Pat Currie** of his latest adventure. "Although I didn't play baseball at M.I.T., my interest never waned and I kept myself in shape playing summer ball in the industrial leagues in Milwaukee. Last year's championship game (in which I went 3 for 4 with two doubles) was attended by scouts from the Braves and the Angels, who asked me if I was interested in trying out this spring. Well, after a miserable first term at law school at the University of Wisconsin, the thought of achieving my lifelong ambition, to play baseball with Henry Aaron, seemed better than ever so I contacted Atlanta and they invited me down to camp. It was a gas. I was in great shape physically, but my skills looked pretty bad next to guys who had been playing pro ball since the age of 17 or 18. To make a long story short, I couldn't hit the curve, made five errors in the four innings I played (at second base, a concession to my non-major-league-short-stop's arm) and stole no bases in two attempts. After that performance I was 'put on waivers for the purpose of giving me my unconditional release' (baseball's euphemism for getting the bum's rush), a distinction I share with Denny McLain (he of the 31 wins). I'm currently back in Madison waiting for summer school and a return to law school."

In other news, **Alex Makowski**, erstwhile editor of *The Tech*, is working as an editor for Jay Forrester, and is about to return to school as a grad student in management at the Institute. He is married and Jessica and he are living in Hyde Park with a move to Cambridge imminent. . . . **Bob Dwyer** was married in April. He and Kathy have found an apartment in East Providence and Bob starts work on a doctorate in oceanography at the University of Rhode Island in September.—**Dick Fletcher**, Secretary, 135 West St., Braintree, Mass. 02184

Conversation Pieces

Technically intriguing items from TRW, guaranteed to add luster to your conversation and amaze your friends.

Storm on the Sun In Einsteins's famous equivalence of mass and energy, $E = m C^2$, the C^2 turns out to be a very large number (186,000 mi/sec × 186,000 mi/sec). This means that the destruction of a very small amount of matter yields a very large amount of energy. The immensely destructive forces released by a small hydrogen bomb are dramatic evidence of this fact.

We can begin to appreciate the staggering amount of energy put forth by our sun when we realize that every second the sun converts 5 million tons of mass into energy and radiates it out into space. Light, heat, X-rays—in fact, the entire electromagnetic spectrum—stream forth from this hydrogen-fueled holocaust. In addition, subatomic particles such as protons and electrons are hurled into space carrying with them magnetic fields. This plasma, called the solar wind, blows through the solar system forming a kind of interplanetary weather.

Our own spacecraft earth courses through the solar wind much like a ship plowing through the sea. At its prow, the belts of radiation trapped by earth's magnetic field (the Van Allen belts) are buffeted then flattened by the solar wind and a bow shock wave is formed. Behind, an electromagnetic wake trails out for thousands of earth radii (see Figure 1).

Ordinarily the speed of the solar wind is relatively steady. Sometimes, however, a storm erupts on the sun, and the wind is whipped to hurricane proportions. When this occurs, the earth experiences the assault of a full-blown magnetic storm.

On August 2, 1972, an enormous storm, the largest ever measured in space, suddenly erupted on the sun. Flares leaped hundreds of thousands of miles above the solar surface, and huge discharges of plasma hurtled into space. As the storm slashed out through the solar system, NASA's Pioneer 9 satellite was in orbit between the earth and the sun; Pioneer 10, on its way to Jupiter, was travelling through the asteroid belt. The alignment of the two spacecraft had been anticipated by Pioneer engineers and scientists as an important opportunity to evaluate the normal flow of solar radiation. The giant storm was an unexpected bonus.

Pioneer 9 clocked the gust of solar wind at 2¼ million miles per hour. By the time it struck Pioneer 10, 76 hours later, the wind had slowed to around 1 million miles per hour. Interestingly, its temperature had shot up to nearly 2 million degrees, and the interplanetary magnetic field was 100 times its normal strength. The effects are suggestive of the magnetic "pinch" that scientists seek to control fusion reactions.

After settling down, the sun erupted again on August 7. During this storm NASA's Pioneer 6 satellite counted the greatest number of high energy particles ever seen, over 4,000 times more than normal. In a one hour period, the storm produced energy equal to the U.S. electrical power consumption for 100 million years. As an aside in parting, it warped the earth's magnetic field so severely that power and communication blackouts occurred in Canada, the northern U.S., Sweden and Alaska.

The data collected by these TRW-built satellites during the solar storms of early August are now being evaluated to determine their effect on current theories of the space environment, the earth's atmosphere, and other aspects of space physics. The information is expected to increase our understanding not only of our own star, the sun, but of other stars in the universe as well.

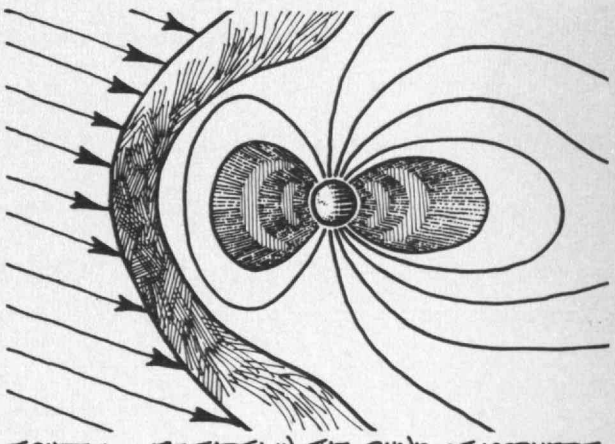


FIGURE 1. THE EARTH IN THE SUN'S ATMOSPHERE

For further information, write on your company letterhead to:

TRW
SYSTEMS GROUP

Attention: Marketing Communications, E2/9043
One Space Park Redondo Beach, California 90278

Citibank—the bank to look to for simplifying multi-currency transactions. In Panama City—and around the world.

Panama, as a key open dollar market in Latin America, is a major crossroads for the world's currencies as well as its commerce. Here, Citibank is right in the middle of it with a complete range of banking services. We're in all the major money markets, worldwide, from London to Singapore, from Tokyo to Zurich. Wherever you have a multi-currency problem you can count on Citibank for the service you need—including a global transfer system that gets cash where you want it in 24 hours. Citibank is where the action is, in 91 countries around the world.

MEMBER F.D.I.C

FIRST NATIONAL CITY BANK
Broadest Shoulders in the World of Banking

Just say "Citibank"

Panama City Citibankers in front of the Iglesia El Carmen.